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# Natural History Papers

## National Museum of Canada

DEPARTMENT OF NORTHERN AFFAIRS
AND NATIONAL RESOURCES

OTTAWA

NUMBER 1 AUGUST 18TH 1958


# A HORSE ASTRAGALUS FROM THE HAND HILLS CONGLOMERATE OF ALBERTA

LORIS S. RUSSELL

## INTRODUCTION

The Hand Hills conglomerate, except for soil, forms the summit of the Hand Hills in townships 29 and 30, ranges 16 and 17, west of the 4th meridian. This is about 15 miles east of Drumheller, Alberta. The deposit lies about 3,500 feet above sea-level, and about 700 feet higher than the general level of the surrounding plain. The conglomerate rests unconformably on the sandstones and shales of the Paskapoo formation, Paleocene in age, which in turn rest upon the rocks of the late Cretaceous Edmonton formation.

Exposures of the Hand Hills conglomerate are mostly small and weathered. The exception is a large artificial excavation for gravel, located in the N.W. ¼, Sec. 32, Tp. 29, Rge. 17. As exposed here, the deposit consists of about 15 feet of conglomerate, in part cemented, in part almost unconsolidated. The constituents are mostly of cobble size rather than pebble, the average being about 3 inches in diameter, but larger and smaller sizes are common. In composition these cobbles are brown and grey quartzites and cherts. The matrix is a grey, medium-grained sand or sandstone, and the cementing agent is in part siliceous.

## OCCURRENCE

The specimen here described was found at the base of the low cliff which forms the east wall of the gravel pit. It was in three well-separated pieces, which were readily reassembled; a fourth, smaller fragment from the ventral side of the bone was not recovered. No portion of the bone was

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actually in place in the deposit, nor was any impression visible from which the bone might have come. However, it is considered certain that it had fallen from some level in the adjacent cliff wall. It probably came from the lower 10–foot portion, which is terminated above by a temporary roadway. However, the remainder of the pit wall, above the roadway, is also composed of Hand Hills conglomerate, up to the soil level. The bone itself is heavy and brittle, obviously mineralized, so there is no possibility of it being of modern age, and having fallen into the pit from the surface. The surface of the bone bears fine colour banding, like contour lines, evidently the stains from bedding planes. This last-mentioned feature suggests that the astragalus came from one of the bedded sand lentils, rather than from the conglomerate.

Figure 1. Cf. *Plesihippus* sp., right astragalus, National Museum of Canada No. 9449 dorsal view; Hand Hills conglomerate, Hand Hills, Alberta; X 1.

## DESCRIPTION

The specimen (fig. 1) is obviously the astragalus of a perissodactyl, as shown by the single trochlea, and the short, truncated distal portion. Of the three groups of perissodactyls occurring in the Tertiary of western Canada, and likely to have astragali of this size, the titanotheres and rhinoceroces can be ruled out by the fact that the trochlea of this specimen is deep and oblique. The equine nature of the bone is unmistakable, and it will be described in comparison with the astragalus of the modern domestic horse.

In size the bone is somewhat smaller than the average for *Equus caballus*. The trochlea is as oblique, but is not quite so deep, relatively. The area on the dorsal surface between trochlea and distal articular surface is relatively larger than in *E. caballus*. The distal tuberosity is about equally massive. On the ventral side (fig. 2) the articular facettes for the calcaneum are not

so clearly defined, but this may be due to post-mortem wear. The V-shaped depression formed between the lateral ridge of the trochlea and the outermost facette is less acute than in *E. caballus*, that is, the depression is relatively more shallow. The length of the Hand Hills astragalus is 56.7 mm., and the maximum width between parallels is 61 mm.

Figure 2. Same specimen as figure 1, ventral view; X1.

## SYSTEMATIC POSITION

All of the features of this astragalus suggest an advanced type of horse. Comparison with Pliocene horse astragali in the collection of the Nebraska State Museum showed that closest resemblance is to examples from the Kimball formation (Upper Pliocene), but even in these the size is not as large, and the trochlea not as deep or as oblique. Dr. Wann Langston, Jr., has compared the Hand Hills specimen with horse astragali in the collection of the University of California. He reports that it has close resemblances to those of the late Pliocene or early Pleistocene genus *Plesihippus*. There is also some resemblance to the larger examples of astragali of *Hypohippus*, a genus which ranges from Lower Miocene to Lower Pliocene. It is not proposed to attempt a more precise generic comparison at this time. The specimen clearly indicates a late Tertiary age for the Hand Hills conglomerate, with probability favouring a late Pliocene date.

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OTTAWA, 1958

Cat. No. R92–858

# Natural History Papers

## National Museum of Canada

DEPARTMENT OF NORTHERN AFFAIRS
AND NATIONAL RESOURCES

OTTAWA

NUMBER 2 AUGUST 18TH 1958


# CHAMPSOSAUR GIANTS


WANN LANGSTON, JR.



## ABSTRACT

Some Paleocene and Eocene representatives of the late Cretaceous and early Tertiary reptilian suborder Choristodera in North America and Europe, attained a size appreciably larger than earlier members of the group. This suggests a tendency toward gigantism among champsosaurs parelleling trends seen elsewhere in various reptile groups as these approached extinction.


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The tendency toward gigantism, widely recognizable in various reptile groups as these approached extinction, has evidently not been noticed in the Choristodera. These enigmatic but supposedly eosuchian reptiles of strikingly gharial form are best exemplified by the North American genus *Champsosaurus* whose spool-shaped vertebral centra are such common fossils in certain late Cretaceous and early Tertiary deposits. *Champsosaurus* suffers by comparison with the relatively huge contemporaneous dinosaurs and is usually depicted as a creature of modest proportions. Most late members of the group which survived into the Paleocene and early Eocene seem to have been no larger, or even smaller, than older ones. Discovery of relatively huge champsosaur remains of Paleocene age is thus not without interest.

The specimens were collected in 1918 by Professor A. MacLean, then of the Geological Survey of Canada. The most diagnostic bone is a presumed late dorsal vertebral centrum (N.M.C. No. 2435). It was picked up on a dump at the Wee McGregor coal mine in Legal Subdivision 1, section 36, Township 1, Range 7, west of the 2nd meridian. This is about 10 miles southwest of

Estevan, Saskatchewan. The other bones comprising parts of a few ribs (N.M.C. No. 2438) are said to have come from above the coal seam in the mine. Whether the vertebra and ribs were associated is not clear, but their similarly large dimensions suggest that they may have belonged to a single population, if not to one individual. The coal and superjacent rocks at this locality are mapped as Ravenscrag formation of Paleocene age. More refined dating has not been attempted.

The centrum is compared in the accompanying illustration with another of more usual size of Cretaceous age. The two bones are fairly similar in form and proportions, which are characteristic of champsosaur presacral vertebrae generally. Differences in shape of the neurocentral surface indicate a different position in the respective vertebral columns and reflect somewhat heavier parapophyses in the larger bone.

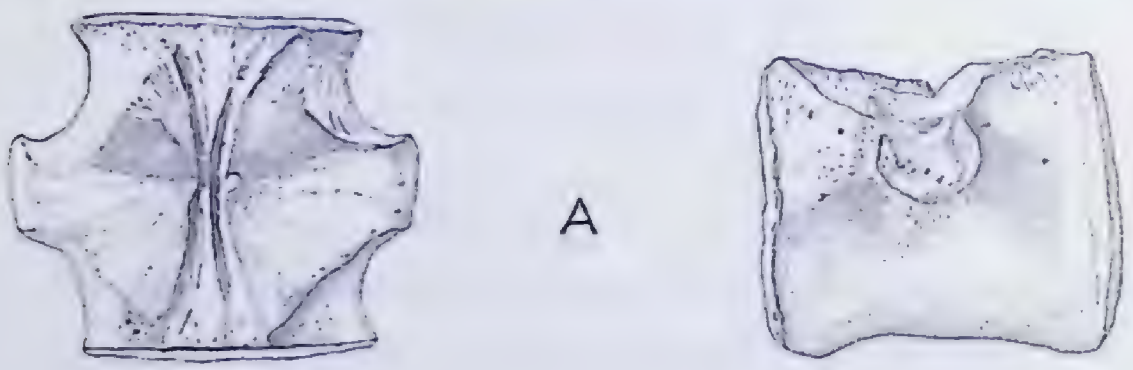


Figure 1. Dorsal centra of champsosaurs compared, dorsal and lateral aspects. A, a Cretaceous *Champsosaurus;* B, the large Paleocene fossil from Saskatchewan, approximately natural size. Drawings by P. R. Haldorsen.

In size the vertebra from Saskatchewan exceeds the largest of many *Champsosaurus* vertebrae in the National Museum of Canada by at least one-fourth and is about twice as large as the average. It is 43 mm. long, 38 mm. high posteriorly, 41.5 mm. wide across the posterior face, and has a

maximum transverse diameter across the parapophyses of about 50 mm. The twentieth postcranial centrum (the last and largest preserved) in a large specimen of *Champsosaurus natator* Parks recently mounted in the National Museum of Canada (Russell, 1956) has corresponding measurements of 31.6, 30.0, 31.0, and 39.2 mm., respectively. This specimen has a skull 475 mm. long, and as reconstructed the skeleton is in the neighbourhood of 240 cm. long. This is about 25 per cent larger than the average of several *Champsosaurus* skeletons in the Royal Ontario Museum, American Museum of Natural History, University of California (Berkeley) and the National Museum of Canada, which range from less than one to about 2.4 m. in length. Tails of all these specimens are incomplete, but a skeleton in the Royal Ontario Museum lacks only a few caudal vertebrae (Parks, 1933); the larger National Museum skeleton is reconstructed with comparable proportions. Similar calculations—conservatively assuming the centrum from Saskatchewan to have been the largest in the column—give a length of about 3.26 m. for the complete skeleton. Hence the animal was much larger than any other North American champsosaur known to me *(Ischyrotherium antiquum* Leidy, whatever it may be, is certainly not a champsosaur as implied in the 1902 Hay Bibliography). The living animal perhaps weighed between 400 and 500 pounds, comparable to modern crocodilians of similar length. It probably bulked with or surpassed the largest eusuchian crocodiles of its day. Since specific or even generic assignment of such meagre remains (contrary to some earlier practice) is impractical, the champsosaur from Saskatchewan shall remain nameless.

The Choristodera has long been recognized in early Tertiary deposits of Europe, where the name *Simoedosaurus* has been applied to bones of champsosaurian form (Dollo among others has argued for synonymy of *Simoedosaurus* and *Champsosaurus,* the latter having priority). Detailed morphological comparison of *Simoedosaurus* vertebrae with the specimen from Saskatchewan is pointless, except to note that the latter resembles *Simoedosaurus* vertebrae (Dollo, 1885) about as closely as it does vertebrae of *Champsosaurus* from North America. But vertebrae of *Simoedosaurus* approach it more nearly in size; Zittel estimates the length of a living *Simoedosaurus* at about 2.5 m., but a skull figured by Dollo (1891) suggests a longer animal. *Simoedosaurus* and the slightly older champsosaur from Saskatchewan may be closely related, but it seems as likely that they represent parallel trends toward increasing size among later species of Choristodera.

The Choristodera appear suddenly in the geological record of the late Cretaceous. They survived the great extinctions at the end of the Mesozoic but finally succumbed to causes unknown during the early phases of Eocene time. The Eocene *Simoedosaurus* and Paleocene champsosaur from Saskatchewan, may be evidence of a trend toward gigantism (a relative term after

all) that appeared during the later history of the suborder, thus paralleling many unrelated reptile groups of late Palaeozoic, Mesozoic, and Tertiary times.

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DEPARTMENT OF NORTHERN AFFAIRS
AND NATIONAL RESOURCES

OTTAWA

NUMBER 3 SEPTEMBER 23 1959

# ANCHICERATOPS FROM THE OLDMAN FORMATION OF ALBERTA

WANN LANGSTON, JR.

## ABSTRACT

*Anchiceratops* is reported from the Upper Cretaceous Oldman formation of southern Alberta; its geologic range is thus extended downward. Analysis of *Anchiceratops* occurrences shows that these are practically confined to sedimentary deposits where other ceratopsians are uncommon. A correlation exists between them and dark-coloured, non-coaly, fine-grained sediments deposited near the strand in regions of low relief. In life, *Anchiceratops* seems to have been a relatively stenopic dinosaur inhabiting low-lying, possibly swampy, situations not particularly suitable to related ceratopsians.

Sometimes reference to *Anchiceratops* in the context of an "index" to the Edmonton formation violates biostratigraphic principles, but *Anchiceratops* remains are apparently restricted to sediments of the Lower Edmonton facies of appropriate age within a restricted palaeogeographic realm.

## INTRODUCTION

*Anchiceratops* Brown was a late Cretaceous long-horned dinosaur of moderate size and massive proportions. Its moderately widely-fenestrated frill bore large marginal epoccipital bones of characteristic form, and posterodorsally a pair of unique outwardly-hooked osteoderms of like origin lay astride the midline. Two species—*A. ornatus* Brown and *A. longirostris* Sternberg—have been described on the basis of differences in the proportions

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of the frills, broad and massive in the first; elongate, narrower, and more lightly built in the second. All specimens of *Anchiceratops* hitherto reported have come from the Edmonton formation exposed in the badlands along Red Deer River north of Drumheller, Alberta. *Anchiceratops* left no descendants; its heritage is doubtless associated with the long-frilled (chasmosaur) line of ceratopsian dinosaurs, but it is not derivable from known species.

The National Museum of Canada possesses part of a ceratopsian frill from the Oldman formation (= Belly River, Pale Beds, etc., of older reports) that C.M. Sternberg (1949) once compared to *Anchiceratops*. Re-examination of this specimen and recognition of another from approximately the same horizon confirm their essential *Anchiceratops* affinities. In so far as comparisons are possible, the more complete specimen resembles *A. longirostris* closely; the other is reminiscent of *A. ornatus*, but certain assignment is impossible. Provisionally both specimens are referred *Anchiceratops* sp.

## DESCRIPTION OF MATERIAL

The specimens were collected by the National Museum expedition of 1937. The more complete one (N.M.C. No. 9813), which consists of much of the right squamosal and adjacent parietal, has attached the second to seventh epoccipital bones[1] (counted from the midline), but of the postdorsal boss nothing remains. The edges of the fenestra of the frill are not preserved, but near its former margin the bone becomes very thin and very little has been lost. There is no trace of the centre bar of the frill.

This specimen was found *in situ*, "about 12 feet above a light gray sandstone bed," near the top of the Oldman formation as exposed in legal subdivision 14, Sec. 24, Tp. 2, Rge. 4, west of the Fourth Meridian (Sectional Map 16, Milk River, Alberta). This locality (P-3706) is about 22 miles southeast of the town of Manyberries. An outlier of marine Bearpaw shale occurs conformably above Oldman beds a few hundred yards to the northeast and stratigraphically but a few feet above the fossiliferous horizon.

The second specimen (N.M.C. No. 9814) comprises three epoccipital bones, two of them attached to a piece of frill, and one of the characteristic *Anchiceratops* postdorsal frill-bosses. It has weathered from a soft matrix, possibly a sandy claystone. The locality (P-3705) is on the line between sections 10 and 15 just east of the quarter-section post in Tp. 3, Rge. 5, west of the Fourth Meridian. This is about 14 miles south-southeast of Manyberries and 10 miles northeast of the other *Anchiceratops* locality. In view of the prevailingly slight regional dip, the fact that both localities are near the

(1) The term "epoccipital" was first applied to the marginal osteoderms of ceratopsian frills in the Hatcher Marsh Lull monograph. The name is misleading because the bones have nothing to do with the occipital complex of cranial bones and they are not particularly "epoccipital" in position. Romer has abandoned the word in *Osteology of the Reptiles* (similar bones occur in some lizards, turtles, and placodonts, but are evidently not designated by special names). However "epoccipital" has found such wide usage by students of the Ceratopsia that its continued employment seems justified on grounds of utility.

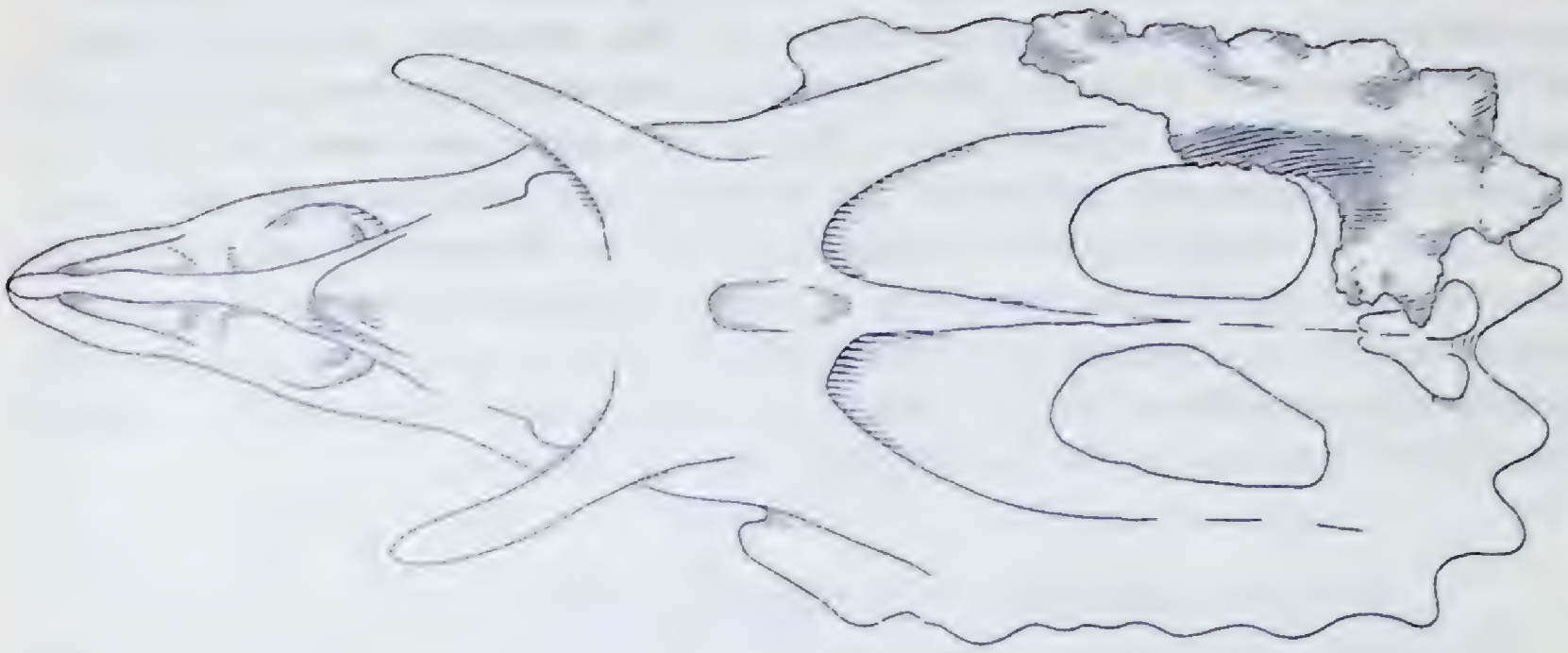

Figure 1. Fragment of the frill of *Anchiceratops* sp. from the Oldman formation (N.M.C. No. 9813) superimposed on a somewhat schematic reconstruction of the holotype skull of *A. longirostris* Sternberg (N.M.C. No. 8535). Frill fragment approximately 1/16 natural size, skull reduced to scale.

3200-foot contour line (Map 567A, Dunmore, Alberta) suggests a similar stratigraphic position within the upper fifty feet of the Oldman formation as developed here. Carbonaceous and estuarine deposits are prominent near both localities, and the fossiliferous strata are associated with the Lethbridge member of the Oldman formation.

The shape and arrangement of epoccipital bones in No. 9813 coincide closely with those in a skull of *Anchiceratops longirostris* Sternberg (Figure 1). The bases of the epoccipitals are embedded in a fibrous exostosis which attaches the bones to the edge of the frill. The reticulate texture of this material is characteristic of the basal surfaces of reptilian osteoderms generally. The larger epoccipitals at least (better shown by No. 9814) contain a central cavity at the base into which is inserted a corresponding projection from the edge of the frill. Deep semi-longitudinal sulci on the ventral surface of the squamosal resemble the profound sculpture of the skull of *A. ornatus* figured by Brown (1914, pl. 30).

The only useful measurement that can be made of this specimen is the diagonal distance from the medial base of the second epoccipital bone to the anterior end of the seventh, approximately 533 mm. The frill was thus about a sixth smaller than that of the skull of *A. longirostris,* referred to above. It was considerably smaller than several *A. ornatus* frills and may have been intermediate in width between these and *A. longirostris.*

The epoccipitals of the second specimen are much larger than those of No. 9813 or the compared *A. longirostris* specimen, but smaller than

usual in *A. ornatus*. The frill bone remaining is thicker than in *A. longirostris*. Surfaces are rough and porous, and the interiors are cancellous—possibly the normal state in *Anchiceratops* not usually revealed by fossil material. Some of the ventral sulci of the frill bone are seen to pass unconstricted beneath the edges of the epoccipitals. The hooked boss, one of the pair so distinctive of *Anchiceratops*, is incomplete at the base. Where broken, its internal structure is seen to resemble that of the epoccipital bones, but it cannot be determined if a node was present on the frill beneath this osteoderm. Brown (1914) stated that the bosses of *A. ornatus* were suturally united to the underlying bones of the frill.

## SIGNIFICANCE OF THE OLDMAN ANCHICERATOPS

As sometimes happens when fossil vertebrates with seemingly brief stratigraphic ranges are concerned, palæontologists have become accustomed to thinking of *Anchiceratops* in terms of the classic "index fossil" concept. Thus the genus has sometimes been considered "typical" of the Edmonton formation in a temporal sense, in violation of biostratigraphic principles. That *Anchiceratops* may be distinctively associated with a specific physical environment which is reflected in a certain lithologic "Lower Edmonton" facies (s.l.) will appear from what follows.

A few remarks on the character and relationships of the Oldman and Edmonton formations will provide a framework in which to discuss the occurrence of *Anchiceratops*. My remarks apply specifically to the development of the Oldman formation of the Milk River–Manyberries area and of the Edmonton formation exposed along Red Deer River near Drumheller and northward to Rumsey, Alberta.

Sternberg (1947, 1949) and others have followed Allan and Sanderson (1945) in referring to three members of the Edmonton formation. That this practice generally does not conform usefully to conditions in the field has been shown by Tozer (1952). Although the Drumheller "marine" tongue that has been employed to divide a lower from a middle member has proved helpful as a datum in vertebrate palæontological work in the Drumheller area, its intermittent and stratigraphically vagrant characteristics make the tongue unsuitable for most stratigraphic purposes. Its principal significance is to show that this region of Alberta was subject to repeated, though minor, fluctuations in sea-level and that the strand line of the retreating Bearpaw sea was not far distant at times.[2]

Lithologically, there seems little difference between beds immediately above and below the Drumheller tongues, wherever they are present. Elsewhere these lower and middle "members" are inseparable.

(2) Tozer (1956) notes that the varied invertebrate fauna of the Drumheller "marine" tongue has a brackish water aspect and that in outcrops along Bow River it contains freshwater elements.

Higher in the section a water-laid tuff of great lateral extent—the Kneehills tuff—and the subjacent Mauve shale of Allan and Sanderson separate beds of very dissimilar character. The tuff with its distant but apparently easily recognized equivalents makes an ideal marker bed and provides a logical means of dividing the Edmonton formation into an upper and lower member, which usage I shall follow here.

The Mauve shale (correlated with the Battle formation to the east) is somewhat suggestive of a "fossil" soil, and with it the tuff seems to record a depositional hiatus of some temporal significance. Sternberg (1947) has pointed out an important faunal "break" that occurs at about the horizon of the Kneehills tuff in the Red Deer valley, and Bell (1949) notes a corresponding palæofloral phenomenon.

It is from the Lower Edmonton member thus defined that *Anchiceratops* has been recorded previously.

*The age of* Anchiceratops. - Dating of Oldman and Edmonton sediments is fraught with the difficulties inherent in correlating deltaic and flood-plain deposits. Although a degree of control is provided by marine fossils in the Bearpaw formation, which in the south separates the Oldman and Edmonton formations, age assignment in terms of the European Upper Cretaceous stages is tenuous, and it is of doubtful value within the narrow time span involved. Furthermore since these three formations are involved with transgressive and regressive marine phenomena, intraformational ages must vary somewhat from place to place.

The Upper Edmonton member contains the *Triceratops* fauna, which has been assigned a Maestrichtian age (Coban and Reeside, 1952); the rocks are correlated with the Lance and equivalent formations in the western interior of the United States. It is unfortunate that the invertebrate faunules from the Drumheller tongue". . . do not assist in correlation as most of the species are characteristic of brackish-water beds throughout the Montana group," (Tozer, 1956, p. 14). The Bearpaw formation is approximately a late Campanian deposit in southern Alberta. The Oldman formation has been equated to the Judith River formation of Montana (Russell, 1930) and is supposed to be of somewhat earlier Campanian age, at least where it is overlain by datable Bearpaw deposits. But the Oldman–Bearpaw contact rises northward until the marine beds pinch out and Oldman rocks become contiguous with the Edmonton formation above (Shaw and Harding, 1949). Conversely, the base of the Edmonton formation should theoretically become younger in a southeasterly direction. Since the earliest known *Anchiceratops* is from beds below the base of the Bearpaw formation and the latest records from the Lower Edmonton member above the Bearpaw to the north (but some distance from the region where the Oldman specimens occur), the geological range of *Anchiceratops* is a little greater than hitherto supposed.

*The habitat of* Anchiceratops. - The ecological aspects of dinosaurian palæontology have been little studied. By and large the great wealth of morphological data available throughout the world was not collected with ecological considerations in mind—recent Russian collections from Mongolia are exceptions. The present "unexpected" discovery of *Anchiceratops* caused me to review in general the occurrence of this dinosaur. Although the analysis did not provide detailed palæoecological conclusions, the possibility that the methods employed can be expanded and extended to other dinosaurs is inviting. Some illuminating correlations between fossils and sedimentary environments did emerge, which suggest certain conclusions about the habitat association of *Anchiceratops*.

Figure 2 is an attempt to compare graphically the abundance of *Anchiceratops* in relation to other ceratopsians and the associated dinosaurian faunas as a whole within a lithologic and stratigraphic context. Non-dinosaurian elements were ignored owing to inadequate data. The correlation of the faunas in space and time is not of great importance when (as here) short spans and restricted provinces are involved. But in the present example these factors can be graphically shown in a general way and are useful in presenting a more complete picture of the occurrence of *Anchiceratops*.

The sources of my data are given in the caption for Figure 2. It must be emphasized that these data are largely empirical inasmuch as they derive mainly from relative estimates of total abundance of animals *in the field*, and are not confined to census figures of specimens in museums. I am well aware of the possible errors and weaknesses inherent in such subjective estimates. However, field sampling of dinosaurs as manifested by specimens in museums is strongly biased in favour of "display" material. Figures based on museum specimens may provide an entirely erroneous impression of the numbers of animals which actually are preserved. On the other hand it is reasonable to assume that an experienced observer should, over a period of years, come to some useful estimates of the relative numbers of specimens encountered in the field. Provided the systematic refinement demanded is not too great, for example, no more restricted than genera for ceratopsians, family for hadrosaurs, and above family for coelurosaurs, I believe estimates of relative abundance based on expert field observations are likely to be more reliable than a count of specimens in museums. It is important, however, when making comparisons to keep in mind what systematic level is involved. In figure 2 the diagram represents numbers of individuals; the numerals indicating genera of ceratopsians are used to provide a degree of perspective.

*Anchiceratops* has not been found in the Steveville field where the ratio of ceratopsians to hadrosaurs is materially different from that at all

localities where *Anchiceratops* is known to occur. Hence Steveville is not considered here. The sedimentary characteristics of the Alberta Oldman and Edmonton dinosaur-bearing deposits may be summarized (in inverted stratigraphic order).

1. Predominantly sandy, light-coloured, non-bentonitic, fresh water, fluviatile and lacustrine deltaic deposits in the lower part of the Oldman formation. Vertebrates are scarce, ceratopsians not important. These grade upward into

2. more argillaceous, bentonitic, fresh-water "swamp" deposits. Channel sandstones, which are important in the subjacent section, disappear. Numbers of dinosaurs and other vertebrates occur here; ceratopsians include *Monoclonius*, *Centrosaurus*, and perhaps *Styracosaurus*. These comprise between half and two-thirds of the dinosaurian fauna toward the top of this section. Near the top of the Oldman formation the sediments in places grade suddenly into

3. a thin, variable but generally carbonaceous zone which reflects estuarine deposition and conditions favourable to coal formation (the Lethbridge member). A sharp faunal constriction occurs at about this horizon wherever carbonaceous material predominates. *Anchiceratops* appears, and *Chasmosaurus* has been observed. Ceratopsian remains are fragmentary. This is followed by

4. the marine Bearpaw formation which is bounded intermittently above and below by beach deposits and bonebeds comprised mostly of fragments of small aquatic (but non-marine) vertebrates and brackish-water invertebrates.

5. The lower Edmonton member is essentially dark-coloured, evenly-bedded, fine-grained bentonitic clastic sediments. Coal is very important. There is some sandy deposition with channelling locally near the base, and a largely non-coaly section near the middle where the Drumheller tongue is conspicuous. Sedimentary structures characteristic of flood-plain environments appear intermittently throughout the section. Repetitious zones of brown-weathering clay-ironstone concretions are prominent near, but mostly below the Drumheller tongue. Invertebrate fossils represent fresh and brackish water forms. The vertebrate fauna expands upward reaching a maximum near the Drumheller tongue. From there upward, there is a progressively rapid faunal constriction which terminates abruptly against the horizon of the Kneehills tuff. Near the Drumheller tongue *Anchiceratops* seems to be the most common dinosaur and may comprise about half the fauna as a whole. Its remains are very common locally in zones of ironstone concretions. Other ceratopsians, including *Arrhinoceratops* and perhaps *Eoceratops* and *Chasmosaurus*, are very rare throughout this section.

6. The Kneehills tuff - unfossiliferous.

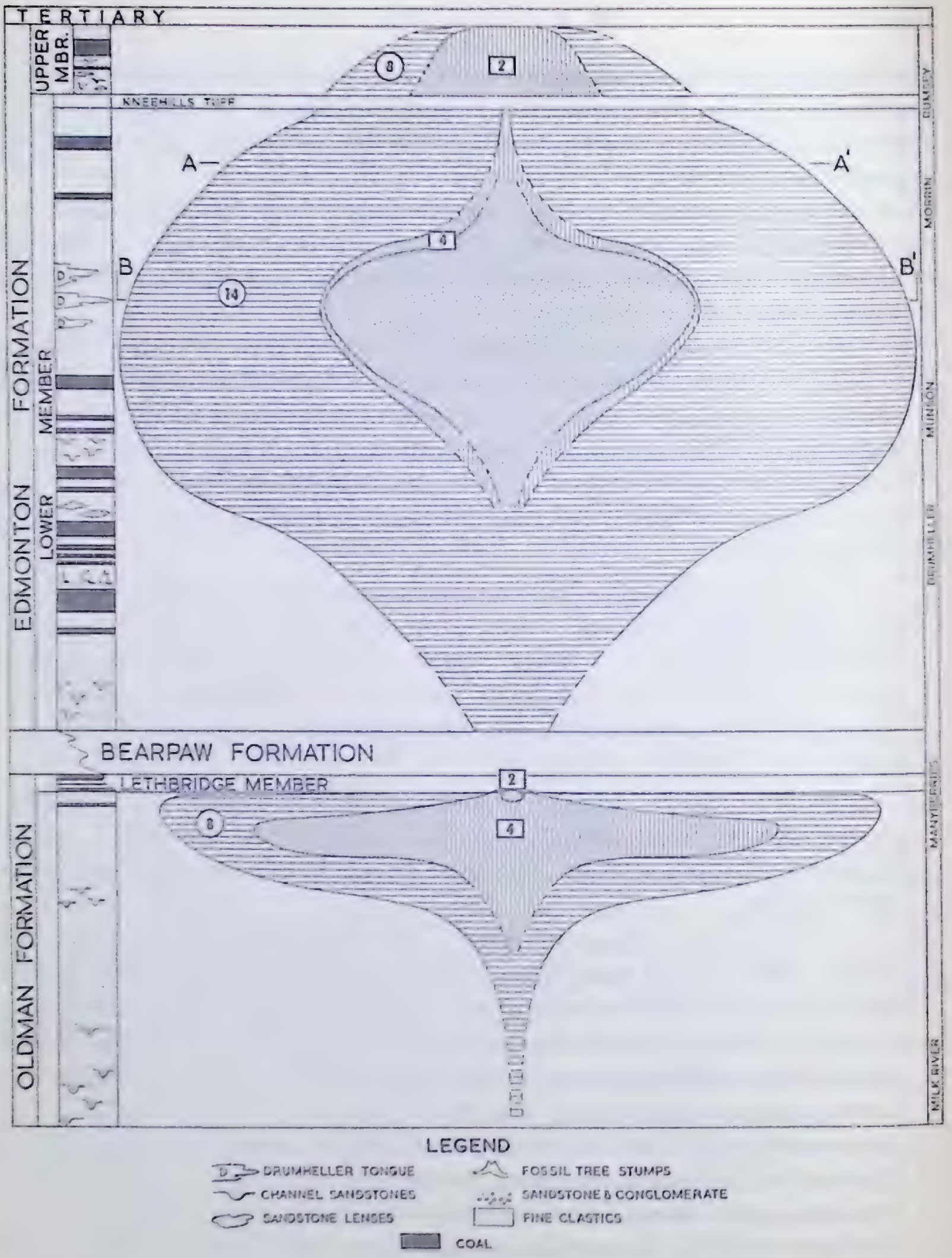


Figure 2. Relationship between dinosaurian faunas and lithologic types in the Oldman and Edmonton formations of Alberta. Oldman beds do not include the section at Steveville, where faunal composition differs considerably from those considered in this paper. The vertical distance suggests relative extent of Oldman and Edmonton outcrops between the Milk River and Red Deer river region north of Drumheller, Alberta. To some degree this distance is proportional to the average thickness of the rocks and

7. The Upper Edmonton member composed of sandier, lighter-coloured, more terrestrial deposits with little coal except at one horizon (the Ardley seam), and little sedimentary evidence of flood-plain depositional conditions. The sedimentary picture seems similar to the lower part of the Oldman formation, but the sandstones are coarser and bentonite is insignificant. The *Triceratops* fauna appears abruptly, and *Anchiceratops* is absent. Besides *Triceratops*, only *Leptoceratops* represents the Ceratopsia here.

It is apparent from this that *Anchiceratops* occurs mostly where other ceratopsians are uncommon. Its remains are often associated with fine-grained clastic sediments that were deposited near the strand line, probably in quiet but not coal-swamp environmental situations. The fact that *Anchiceratops* is well differentiated at its first appearance suggests that its appearance may be correlated with a change in physical environment. The creature apparently found unsuitable the relatively open better-drained situations, evidently preferred by more ubiquitous ceratopsians. In life *Anchiceratops* was evidently restricted to low-lying, even marshy habitats where reducing phenomena predominated. In a sense its remains are characteristic of the Lower Edmonton facies, which is recognizable in modified form in the non-coaly parts of the Lethbridge member in the Oldman forma-

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also indicates latitudinal distances between geographic points of reference (right-hand column). The thickness of the marine Bearpaw formation which has yielded no terrestrial vertebrates of importance is not shown to scale.

Dominant lithologic characteristics of the formations are indicated by symbols at left (data on coal beds in the Edmonton formation are from Allan and Sanderson, other data are from Russell and Landes, from Sternberg, and from my own observations).

The dinosaurian fauna as a whole (outer shape) is taken as unity; its volume is based upon an estimate of individual specimens in museums and in the field, seen but not collected. The ceratopsian fauna (middle shape) is expressed as approximate per cent of the total fauna; relative abundance of *Anchiceratops* (inner shape) is shown as per cent of all ceratopsians based on estimated numbers of individuals. Numerals in circles indicate numbers of genera present including ceratopsians; numerals in squares represent ceratopsian genera including *Anchiceratops* (data from Lull and subsequent works of various authors).

At A-A' the sediments of the Lower Edmonton member exposed on Red Deer river between Morrin and Rumsey are mainly fine clastics with less carbonaceous content than those between Munson and Morrin, at B-B'. Dinosaurs are abundant at B-B' where ceratopsians comprise about half the fauna, but *Anchiceratops* is the dominant genus. For further explanation see text.

It is a pleasure to acknowledge C.M. Sternberg's assistance in compiling the data for this diagram. His vast experience in the dinosaur fields of Alberta has provided the basis for the estimates of numbers of dinosaurs relative to lithologic types.

tion. The disappearance of *Anchiceratops* at the horizon of the Kneehills tuff may be a result of extinction, but the animal would not be expected in the Upper Edmonton member whose sediments bespeak very different environmental conditions.

It might be expected that a creature so narrowly confined to a specific habitat which was unfavourable to closely related species, would display well-marked adaptations to its specific mode of life. But the single known *Anchiceratops* skeleton (described briefly by Lull, 1933) has never been studied in detail or compared with other ceratopsians in a way that would reveal significant differences in proportions. Its face was distinctly elongate as compared to related chasmosaurs. This could have assisted breathing while the animal crossed marshy ground or waded in shallow water. The animal's ability to hold its snout high would have been enhanced by a counter-balance for the head. This was perhaps provided by the elongate and slender frill of *A. longirostris* and the broad massive one of *A. ornatus*, both weighted by the epoccipital bones which are far larger than those of any other ceratopsians except *Styracosaurus*. The tail of *Anchiceratops* is short, and the body as a whole appears to have been more massive than chasmosaurs of comparable length. The limbs were also very stocky. What these features mean in terms of adaptation is not at present clear. They seem to bespeak a sluggish nature that might be expected in animals that enjoyed the relative seclusion and protection of a swampy environment.

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Cat. No. R 95-5/3

JAN 13 1961

Natural History Papers

National Museum of Canada

DEPARTMENT OF NORTHERN AFFAIRS
AND NATIONAL RESOURCES

OTTAWA

NUMBER 4 JUNE 15 1960

# A HADROSAURIAN ICHNITE

WANN LANGSTON, JR.

## ABSTRACT

A large ichnite preserved in an Upper Cretaceous shallow-water sandstone of the St. Mary River formation in southern Alberta, Canada, apparently records a pedal track of a hadrosaurian dinosaur. The broadly tridactyl foot of the animal possessed thick digital, but no distinct phalangeal, pads. A broad "heel" print suggests the presence of a massive tissue pad beneath the metatarsal bundle in the living dinosaur. There is evidence that a web extended between the digits.

Discovery of a hadrosaurian skeleton nearby shows that these dinosaurs existed in the region at approximately the time the footprint was made.

## INTRODUCTION

It is a widely noted phenomenon that vertebrate ichnites and fossil bones of species that could have authored them, rarely occur together in the geologic column. In but few cases has it been possible to correlate fossil tracks with vertebrates known also from skeletal material. This is especially true of non-mammalian tetrapods, and the uncertainties implicit in attempted correlations increase as one goes backward in time and the reassurance provided by comparison with living animals disappears.

Dinosaurian ichnites are common fossils the world over, and comparisons of certain ichnites with the skeletons of the feet coupled with analyses of locomotory mechanics have established a degree of broad corre-

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lation between these and various dinosaur groups. Although in only one case known to me *(Iguanodon)* has the correlation attained the refinement of generic identification, there are many instances where assignment of ichnites to dinosaurian sub- and infraorders seems reasonably well founded. Hence three-toed tracks usually ascribed to carnosaurian and coelurosaurian origin may be correctly identified, and there can be no doubt about the huge tracks assigned to the Sauropoda in many parts of the world. Among the great variety of ornithischian dinosaurs, ceratopsian tracks have probably been recognized (Sternberg, 1932), and I believe a peculiar print recently described by Gabouniia (1951, 1952) probably was made by some armoured dinosaur, although that author believes it is referable to the camptosaurs. The tridactyl tracks of ornithopod dinosaurs are less confidently assignable to smaller systematic groups mainly because of their seemingly infinite variety, but partly because of possible confusion with tridactyl tracks of carnivorous dinosaurs. About the only attempts at refined correlations involve the genus *Iguanodon* s.l. Almost certainly some trackways from Europe (Dollo, 1905; Abel, 1935) are correctly assigned here; others from North America have been referred to "iguanodonts" with (it seems) less reason.

It is remarkable that ichnites of the most abundantly represented North American Cretaceous dinosaurs – the amphibious hadrosaurs – have never been identified with certainty (although some of the North American "iguanodont" tracks could have been made by hadrosaurs). Now the fortuitous discovery of a hadrosaur skeleton near a dinosaurian ichnite in southern Alberta reinforces evidence inherent in the ichnite that this was in fact created by a hadrosaur.

## DESCRIPTION OF MATERIAL

The ichnite (fig. 1) is a natural cast of a pedal impression. It is exposed on the face of a massive block of yellow-weathering sandstone that was thrown out during excavation of the Lethbridge Irrigation Canal in 1923. The dinosaur "track" has been known to the local populace for many years, and it has proved a great attraction to tourists in the region since the adjacent highway was completed. Its "scientific" discovery, however, did not occur until 1955, when Mr. Emmit Ledbetter of Barons, Alberta, led the author and L. S. Russell to it.

The specimen rests precariously on the north bank of the canal a few yards west of the bridge on Alberta Highway No. 23, 1½ miles south of Barons, Alberta, in the northeast quarter of Sec. 4, Tp. 12, Rge. 23, west of the Fourth Meridian. The block weighs several tons and is in imminent danger of toppling into the canal; it cannot long remain in its present position. A latex mould and plaster cast of the ichnite (N.M.C. No. 9487) were made in 1957.

Figure 1. Hadrosaur ichnite from late Cretaceous rocks of Alberta. Drawing from plaster and latex reproductions of original specimen (N.M.C. No. 9487). This presumably represents the configuration of the sole of the right pes — the second digit is to the right. Approximately $\frac{1}{6}$ natural size.

The ichnite is not very sharply defined and has suffered considerably from weathering since it was exposed. The nature of the substrate in which the original track was impressed is unknown. It may have been a slightly fluid pack-sand to judge from the shallowness of the print and the absence of pressure ridges around it. The original footprint was filled by a fine sand that bore comminuted plant material now evinced by fine carbonaceous flakes. (It is not impossible that these fragments were coaly at the time of deposition.) Filling must have occurred rapidly by serial sweeping of the

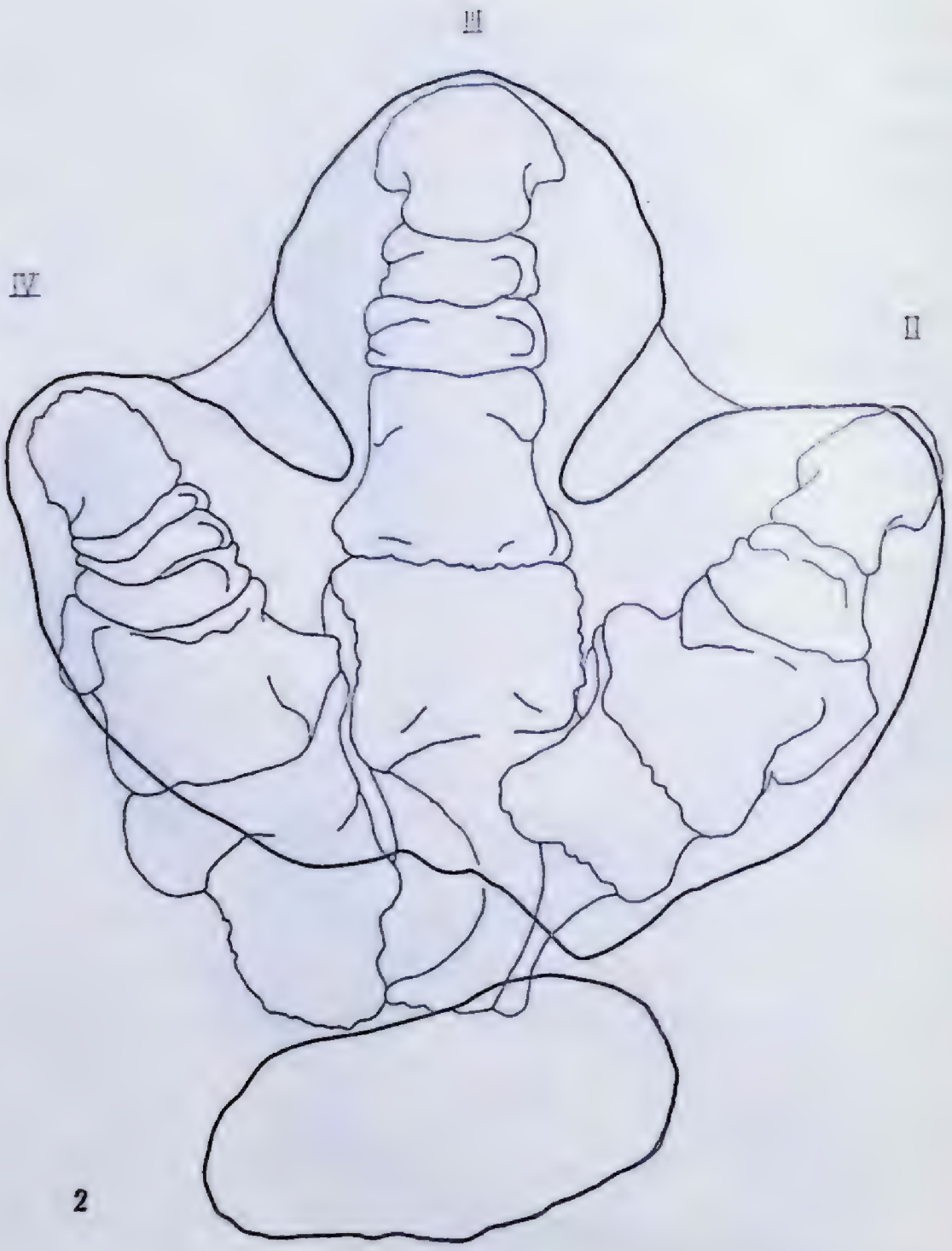


Figure 2. Outline of hadrosaur ichnite shown in fig. 1 superimposed on right pedal skeleton (drawn from below) of the hadrosaur *Hypacrosaurus* (N.M.C. No. 8501). Both drawings are somewhat schematized and simplified. The fourth metatarsal of the skeleton is pathologically deformed, and this may have produced some distortion of the digit. Almost equally good coincidence between skeleton and ichnite can be obtained by reversing the drawing of the foot bones so that the left pes would be reflected. Approximately ⅙ natural size.

sand, which produced a somewhat laminated cast of the footprint. Weathering of the laminated matrix produces exfoliation that has probably reduced the original sharpness of the cast since its exposure to the elements.

The ichnite is large: the greatest anteroposterior diameter measured longitudinally on the middle toe (presumably digit III) is 625 mm, and the maximum spread between extreme tangents to the median and lateral toes is 550 mm. Total digital divarication is very wide, about 62 degrees. The

following description pertains to the original footprint as reconstructed from an interpretation of the ichnite and the latex mould.

The print was broad and widely tridactyl. So symmetrical were the "fat" digital impressions that lacking nodes and interphalangeal constrictions it is impossible to be certain from the single ichnite whether right or left foot made the print. For convenience the track is described in terms of the right pes.

The footprint comprised several broad shallow basins with rounded, sometimes indistinct boundaries and gently sloping sides. The depressions were separated by broad ridges of varying height. Three depressions of irregularly ovate, almost diamond-shaped plan recorded the phalangeal segments of the digits. There were no digital constrictions, except possibly on impression IV, and nodes are nowhere discernible. A broad shallow channel passed backward longitudinally from the phalangeal impression of digit III and disappeared behind into the impression of the metatarsal-phalangeal pad. This was probably the impression of a tensed flexor tendon. The impression of the metatarsal-phalangeal pad was not distinctly subdivided showing apparently that the metatarsal bundle was compact. The pad was most deeply impressed at the proximal ends of digits II and III, but it is not so deep as either of their impressions. The impressions of all digital pads were fairly uniformly concave in longitudinal-vertical section, but the digital impression of IV became very shallow proximally.

Owing to the great breadth of the digital pads, the interdigital salients were narrow despite the great width of the hypexes and broad digital divarication.

There were no distinct traces of ungual structures; the ends of the digital impressions were obtusely rounded and not sharply impressed.

The most interesting feature of this track was the presence of indistinct shallow depressions – visible in low-angle lighting – which concavely bridged the interdigital salients between the widest parts of the phalangeal impressions. There can be little doubt that these marks recorded an interdigital web.

Posteriorly the impression of the metatarsal-phalangeal pad became shallower, but the level of the substrate here did not quite reach that of the surface which surrounded the track. Some fifty millimetres behind the metatarsal-phalangeal depression the raised surface turned downward into an irregularly ovate diagonally-oriented depression, roughly two-thirds as large as that of phalangeal pad II. This depression was flat-bottomed, shallow, and much less sharply defined than the rest of the track. Somewhat comparable marks are seen in presumed *Iguanodon* ichnites from England (Dollo, 1905), but there the presumed "heel" mark is larger relative to the impressions of the digital pads and lies somewhat farther forward than in the Alberta fossil. In the *Iguanodon* ichnites this "heel" mark was sup-

posed to indicate the mode of locomotion of the animals: if it was absent from a footprint, this was made by a running individual; if present and attached to the remainder of the impression, by a walking one; and if present but unattached to the digital impressions, the animal was supposed to have been at rest. Separation of the heel impression from the rest of the print in the Alberta specimen might be explained by the presence of some flat, resistant object under foot, by variation in firmness of the substrate, or by spalling of the sandstone after exposure, if indeed it did not reflect the natural configuration of the sole of the foot. Without a trackway it is impossible to be sure.

## DISCUSSION

The foot that made this track possessed three broad, widely-diverging, blunt-ended digits with very limited inter-phalangeal flexibility (evinced by the absence of inter-phalangeal constrictions). There was a web between the toes. Fleshy phalangeal pads were separated somewhat from a centrally located metatarsal-phalangeal pad, which was in turn followed by a distinct sole pad. Complete phalangeal segments of the digits evidently moved as single units at the metatarsal-phalangeal articulation, but interphalangeal flexion was evidently possible only to a very limited degree.

These characteristics conform well to what is known or suspected of the pedal anatomy of the hadrosaurian dinosaurs. The extent of agreement between the ichnite and the pedal skeleton of a hadrosaur is graphically shown in fig. 2. There the foot skeleton of *Hypacrosaurus* (N.M.C. No. 8501) has been drawn within the outline of the latex mould of the ichnite. Good coincidence is shown in length and disposition of the digits, position of the metatarsal-phalangeal articulation, the inner "heel" at the distal end of proximal phalanx II, and the shape of the terminal ends of the digits. Discrepancies can probably be explained by a slight difference in size between skeleton and ichnite, a deformed fourth toe in the skeleton, and the fact that this footprint was not deeply impressed. Partly preserved casts of disrupted pedal pads in a skeleton of *Corythosaurus* at the American Museum of Natural History were interpreted by Brown (1916, p. 714) as "apparently segmented as lobes under the metatarsals and at least the proximal phalanges". No trace of a web was noted, but a pedal web might be expected in hadrosaurs whose manual digits were evidently completely joined by an apparently fleshy web, which may have extended even beyond the tips of the digits to form a paddle-like appendage (Osborn, 1912; Lull and Wright, 1942, pl. 9c, d).

The sole pad indicated in the ichnite cannot be explained in terms of bony structure. (A part of the foot with osseous support could have made it only by assuming an extended ostrich-like heel-on-ground position that was

Figure 3. Hypothetical sagittal section through third (middle) digit of a hadrosaur foot. The bones shown are those of *Hypacrosaurus*. The astragalus is shown in medial outline so that it appears to overlap the upper end of the third metatarsal. There is, however, a considerable gap between these bones where they oppose each other. Approximately $\frac{1}{9}$ natural size.

manifestly impossible for a large living ornithopod dinosaur.) As do many flightless birds, ornithopod dinosaurs (whose hind limbs bore the major weight of the body even in quadrupedal locomotion) may have evolved elephantine sole cushions in the form of fibrous-tissue pads through which much of the animals' weight was transmitted. In the hadrosaurian foot, for example, such a pad should have been in line with the longitudinal axis of the lower leg in order to carry the weight efficiently and to provide support for the apparently weak ankle joint. It should be noted that this joint in hadrosaurs, though morphologically tarso-metatarsal was functionally more crura-metatarsal in that proximal tarsalia were practically united immovably to the tibia and fibula, whereas the only distal tarsal usually ossified (IV) rested in a basin on the proximal end of its metatarsal and undoubtedly moved with it. The "heel" pad would have served as a prop below and behind the metatarsus especially during dry-land ambulation. It may have been essential when the animals assumed (briefly) a bipedal stance.

The fact that "heel" marks have not been found in many ornithopod tracks may be due to toe-walking in a quadrupedal pose, or to the animals' weight being partly supported by water. The manner in which the footprint from Alberta was filled by successive laminae of sand suggests sweeping motion of shallow waters in which the animal may have lacked buoyant support. A reconstruction based on the above discussion is offered in fig. 3 where again the foot skeleton of *Hypacrosaurus* is shown filling the pedal impression derived from the ichnite.

No other large Cretaceous dinosaur conforms to this analysis as well as a hadrosaur. Reference of an ichnite to a specific group is enhanced if it can be established that appropriate animals were abroad in the same place at the same time. About 150 feet west of the ichnite, on the same side of the canal, there is another large sandstone block that contains natural moulds and fragments of bone representing fourteen mid-caudal vertebrae and chevrons, from what was evidently an articulated skeleton of rare quality. Also preserved on this block are about three square feet of sharply-defined skin impressions. A nearby block contains what is left of the articulated neck and part of the pectoral girdle presumably of the same skeleton. A latex mould of the caudal vertebrae and skin impressions was made (N.M.C. No. 9486), but it was impractical to collect any part of the actual specimens. These remains represent a large hadrosaur, otherwise indeterminate, but possibly a lambeosaurine.

Unfortunately the stratigraphic horizons from which the two fossils came cannot now be determined, and the sandstone surrounding the bones differs somewhat lithologically from that forming the ichnite: the skeletal matrix contains more mica, the ichnite matrix more carbonaceous material. But unless two separate fossiliferous lenses were completely removed during excavation of the canal, the possible stratigraphic interval between ichnite and skeleton could not have exceeded 8 feet, the depth of the water in the canal. This difference is probably temporally insignificant in the fluviatile sediments involved.

The fossiliferous sediments have been mapped as St. Mary River formation, which Tozer (1956) correlates with Lower Edmonton beds of nearby districts. He recorded seven genera of fresh-water molluscs from a spot about 200 yards east of the vertebrate localities and about 25 feet above the bottom of the canal. The age is approximately early Maestrichtian in terms of European biostratigraphic nomenclature, "late Pierre and Fox Hills" in American parlance.

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JUL 4 1960

*Natural History Papers*

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DEPARTMENT OF NORTHERN AFFAIRS
AND NATIONAL RESOURCES

OTTAWA

NUMBER 5

4 July 1960 1960

# KEYS TO THE MARINE FISHES OF ARCTIC CANADA

D. E. McALLISTER

## INTRODUCTION

The increasing interest in the development of the fisheries of northern Canada, for food and for recreation, has resulted in a need for a means of identification. These keys are intended to provisionally satisfy this need.

## SCOPE

The keys include marine and anadromous species of fish, as well as those freshwater species commonly entering brackish water. The key covers species of the Canadian waters of the Arctic Ocean: the Beaufort Sea east of the Alaska-Yukon boundary, the waters about Franklin district (Canadian Arctic Archipelago), Hudson Bay, Hudson Strait east to the northern tip of Labrador, and the waters west of the centre of Baffin Bay and Davis Strait.

## HOW TO USE

The keys are based on a series of statements which are true or false with regard to the specimen that is to be identified. The specimen is first keyed to family, then to species. Start with the first statement, *1.* If it is true, then pass on to the next statement, *2.* If it is false, go to the statement whose number is in parentheses, (6). Using these two simple rules, one continues until one arrives at a true statement with a family or species name below – which is the identification. The key is designed for use only in marine waters of Arctic Canada. References on distribution and taxonomy of these fishes may be obtained from a forthcoming Bulletin of the

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National Museum of Canada by the author, entitled "List of the Marine Fishes of Canada." Common names should be checked with the American Fisheries Society's list of common and scientific names when it is published. A glossary and figures at the end of the paper explain technical terms.

## Key to the Families

1 (6) Five or more external gill openings on each side.

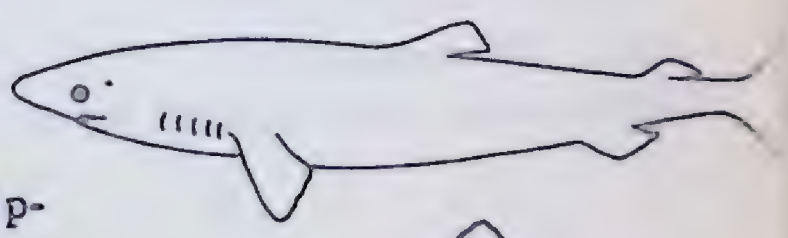
2 (3) Seven gill openings on each side. Lacking pectoral and pelvic fins. Skin completely smooth.

PETROMYZONTIDAE – lampreys (p. 6)

3 (2) Five gill openings on each side. With pectoral and pelvic fins. Skin rough with spines or placoid scales.

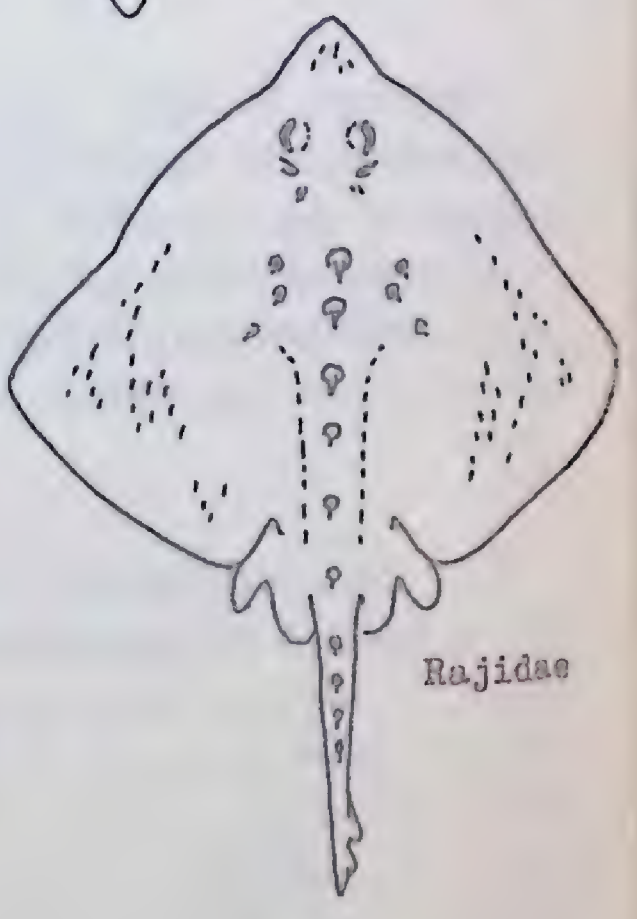
4 (5) Body not flat like pancake. Tail not whiplike.

SQUALIDAE – dogfish sharks (p. 6)



5 (4) Body flat like pancake. Tail whip-like.

RAJIDAE – rays (p. 6)



Rajidae

6 (1) One gill opening on each side.

7 (47) Body not completely covered with thick close-fitting bony plates.

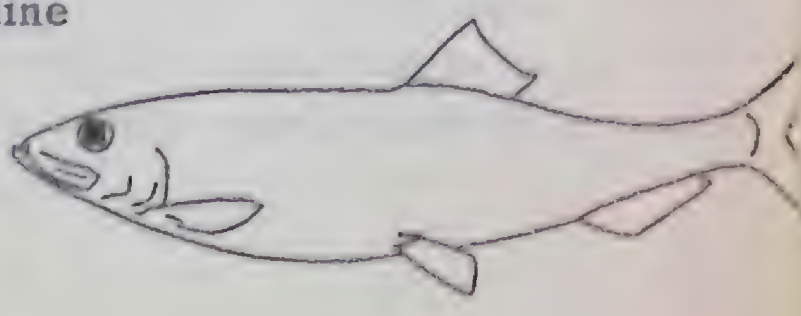
8 (19) One short dorsal fin whose base is shorter than one-third the length of the body. An adipose fin, which is not counted as a dorsal fin, is often present.

9 (16) Base of pelvic fin under the dorsal fin. Without photophores.

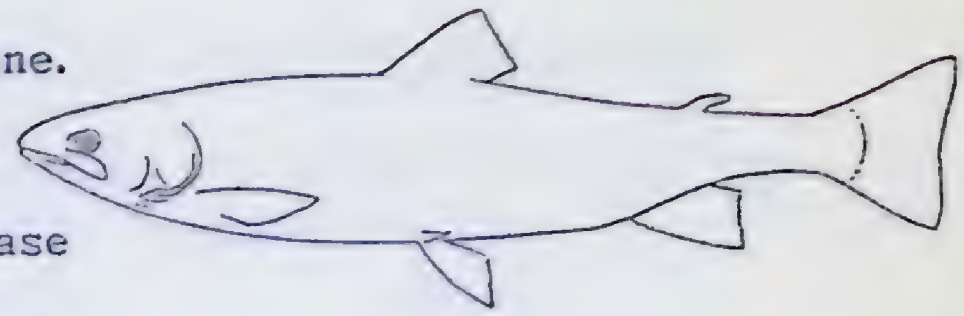
10 (13) Fleshy appendage at base of pelvic fin.

11 (12) Adipose fin absent. Lateral line absent.

CLUPEIDAE – herrings (p. 6)

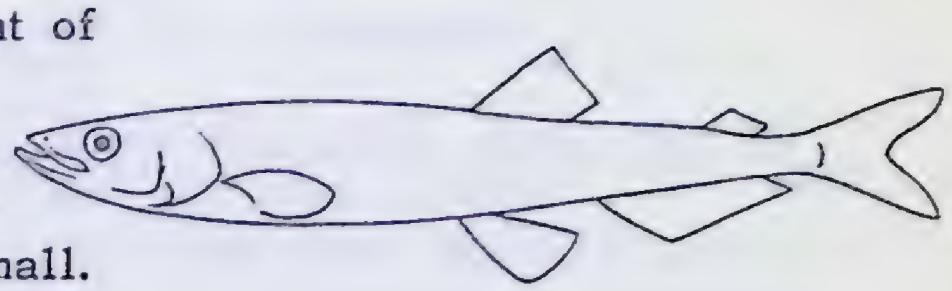


12 (11) With adipose fin and lateral line.
SALMONIDAE – salmons (p. 7)



13 (10) Without fleshy appendage at base of pelvic fin.

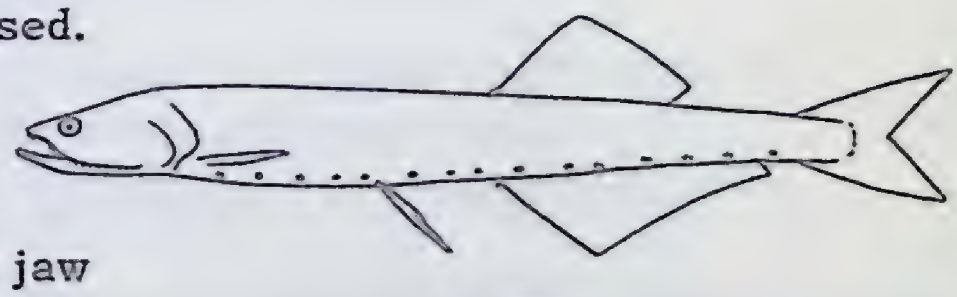
14 (15) Dorsal and paired fins of normal size. Dorsal at about midpoint of body.
OSMERIDAE – smelts (p. 9)



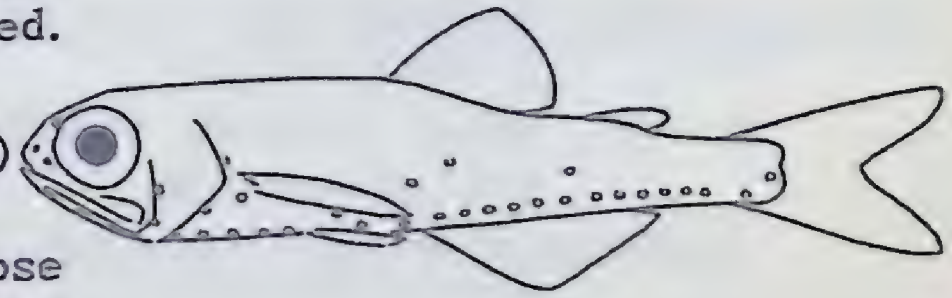
15 (14) Dorsal and paired fins very small. Dorsal considerably behind midpoint of body.
SUDIDAE – (p. 10)

16 (9) Pelvic base in front of dorsal fin. With photophores.

17 (18) Teeth on posterior end of upper jaw exposed when mouth is closed. Pseudobranch absent.
GONOSTOMIDAE – (p. 10)



18 (17) Teeth on posterior end of upper jaw not exposed when mouth is closed. Pseudobranch present.
MYCTOPHIDAE – lantern fishes (p. 10)

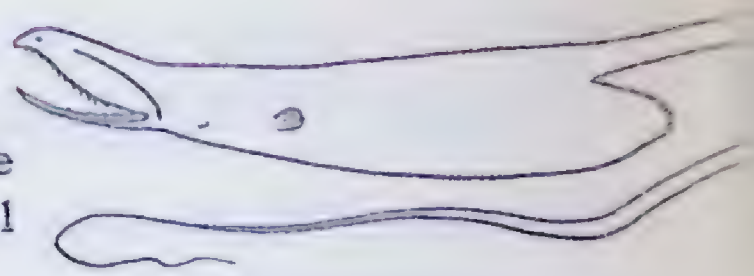


19 (8) Either one long dorsal fin whose base occupies more than one-third the body's length *or* two or three dorsal fins (isolated spines in front of the dorsal count as a fin). Adipose fin never present.

20 (23) Gill openings small and restricted to the ventral half of the body. Jaws unusually long. Rare deep-sea forms.

21 (22) Two ventro-lateral gill slits. Anterior nostril non-tubular.

SACCOPHARYNGIDAE – gulpers (p. 10)



22 (21) Gill slits in a single groove on the ventral surface. Anterior nostril tubular.

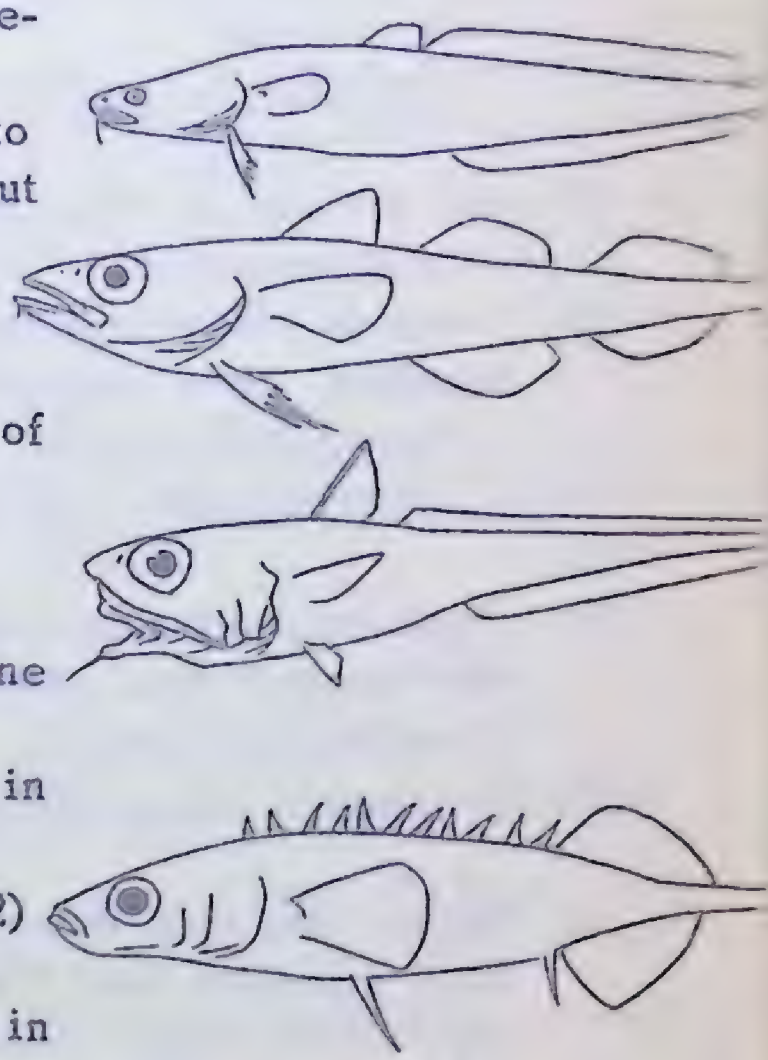
SYNAPHOBRANCHIDAE – deep-sea eels (p. 10)

23 (20) Gill openings large or small, extending above the ventral half of body. Jaws not unusually large.

24 (27) One barbel on tip of chin (except *Pollachius)*; usually three, sometimes two dorsals.

25 (26) Dorsal and anal fins not joined to caudal fin. First dorsal fin without spine.

GADIDAE – cods (p. 10)



26 (25) Fins continuous around hind end of body. First dorsal with spine.

MACROURIDAE – grenadiers (p. 12)

27 (24) No barbel on tip of chin; only one or two dorsals.

28 (29) Sharp isolated dorsal spines in front of dorsal fin.

GASTEROSTEIDAE – sticklebacks (p. 12)



29 (28) No sharp, isolated dorsal spines in front of dorsal fin.

30 (44) Without preopercular spines. One long dorsal fin without notch.

31 (48) Body not greatly flattened; never with a sucking disc or bilobed pectorals or pelvics in filaments as long as head.

32 (37) With pelvic fins (may be quite small).

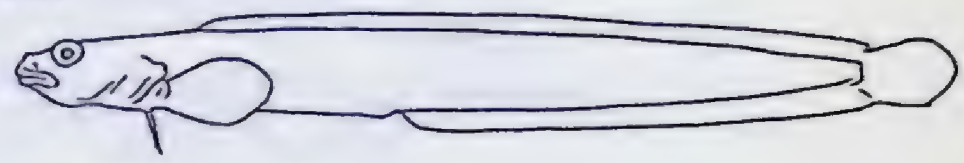
33 (34) Snout protrudes beyond lower jaw. Caudal fin not discernible, fins continuous around hind end of body.

ZOARCIDAE –
subfam. Lycodinae – eelpouts (p. 14)

34 (33) Snout does not protrude beyond lower jaw. Caudal separated by at least a notch from dorsal and anal fins.

35 (36) Pectoral fin large, exceeds length of postorbital portion of head. With pyloric cacae.

STICHAEIDAE (p. 13)



36 (35) Pectoral fin small, less than length of postorbital portion of head. No pyloric cacae.

PHOLIDAE (p. 14)

37 (32) No pelvic fins.

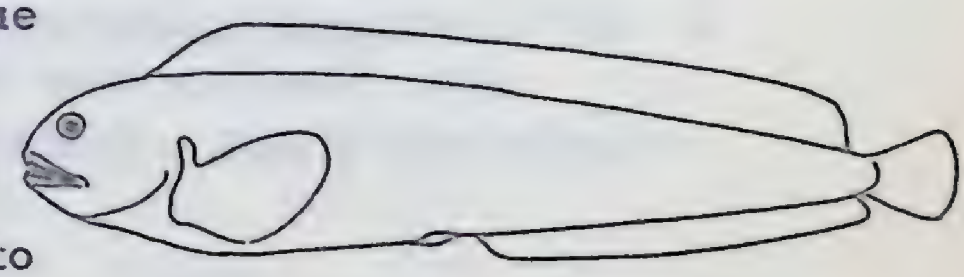
38 (41) Dorsal and anal fins not joined to caudal fin.

39 (40) Lower jaw pointed and projecting beyond the upper jaw. Skin of sides in oblique folds. Caudal fin forked.

AMMODYTIDAE – sandlances (p. 15)

40 (39) Lower jaw not pointed and not projecting beyond upper. Skin of sides of body smooth, not in oblique folds. Caudal fin not forked.

ANARHICHADIDAE – wolf-eels (p. 13)



41 (39) Dorsal and anal fins joined to caudal fin.

42 (43) Pectoral fin shorter than length of postorbital portion of head. Anal with two spines.

PHOLIDAE (p. 14)

See above drawing 36
(only without pelvics)

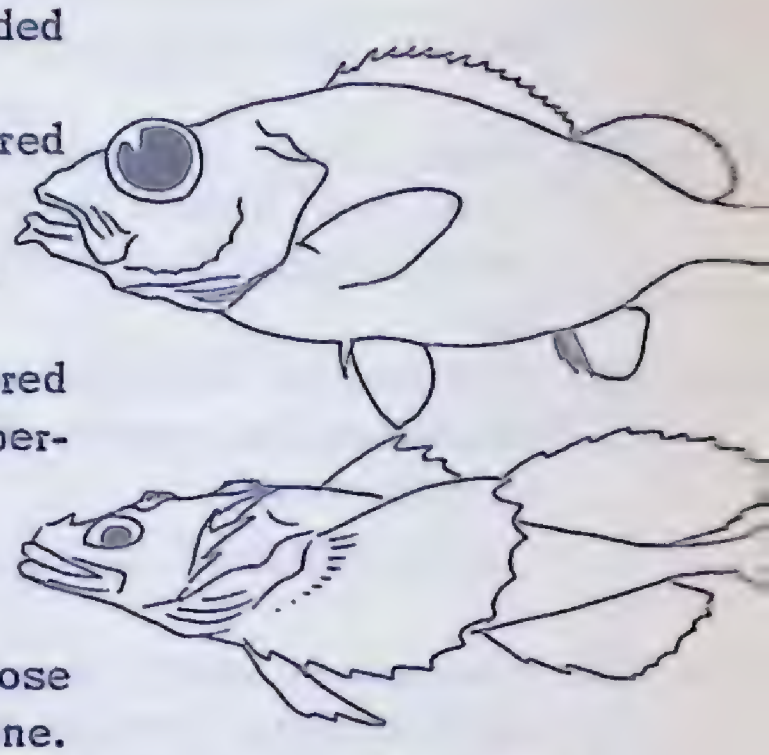
43 (42) Pectoral longer than the postorbital portion of the head. Anal without spines.

ZOARCIDAE – subfam. Gymnelinae – eelpouts (p. 14)

44 (30) With preopercular spines. Two dorsal fins *or* one partially divided by a notch.

45 (46) Three anal spines. Body covered with ordinary scales.

SCORPAENIDAE – rockfishes (p. 15)

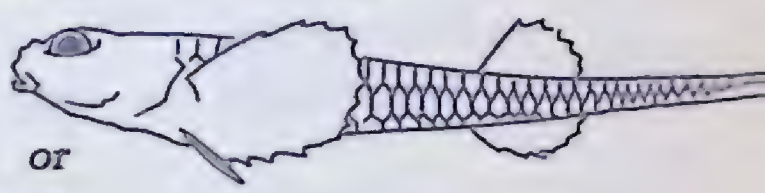


46 (45) No anal spines. Body not covered with scales (naked or with tubercles).

COTTIDAE – sculpins (p. 15)

47 (7) Body completely covered with close fitting bony plates. No anal spine.

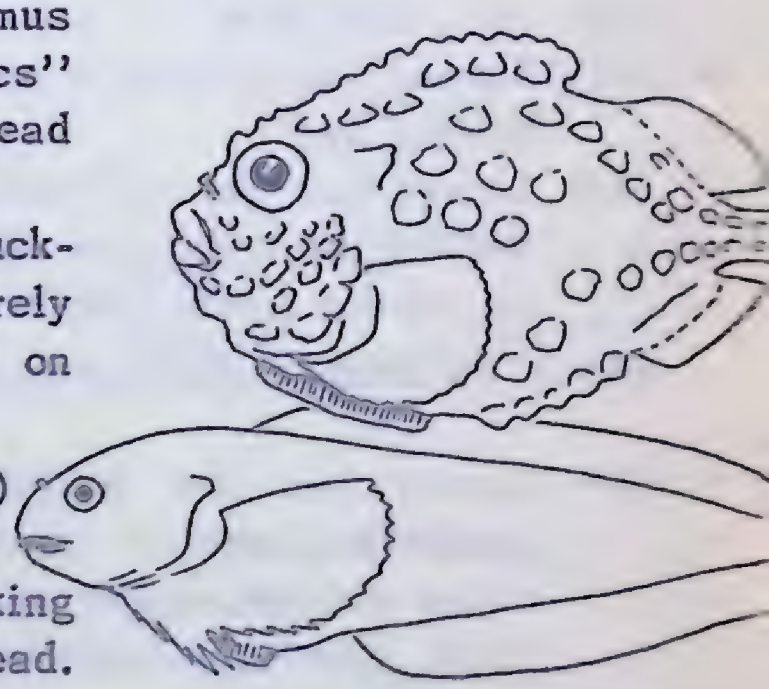
AGONIDAE – seapoachers (p. 18)



48 (31) Body either greatly flattened *or* with sucking disc behind isthmus *or* bilobed pectorals *or* "pelvics" in long filaments equal to head length.

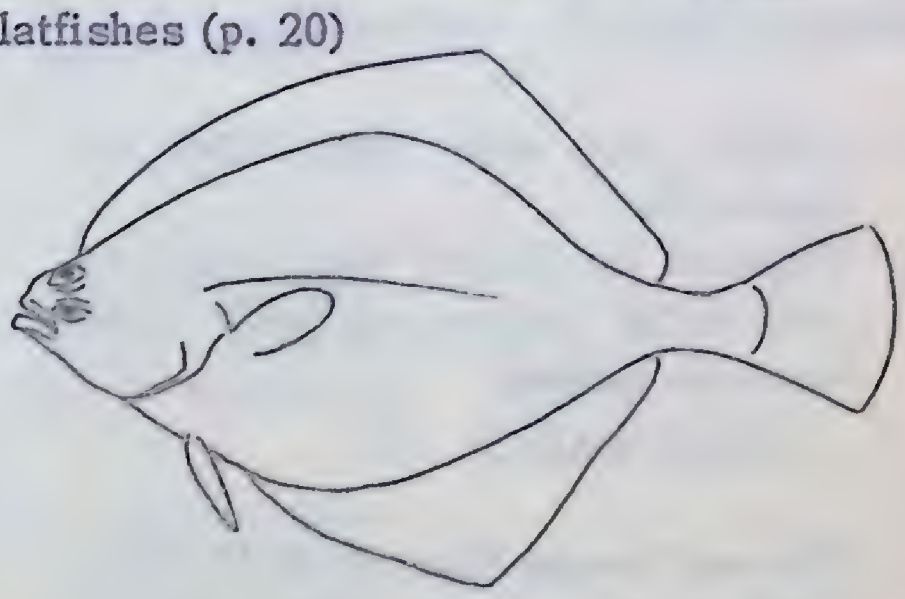
49 (50) Body not greatly flattened. A sucking disc behind the isthmus, rarely absent. Eyes normally placed on opposite sides of head.

CYCLOPTERIDAE – seasnails (p. 18)



50 (49) Body greatly flattened. No sucking disc. Eyes on same side of head.

PLEURONECTIDAE – flatfishes (p. 20)



## Keys to the Species

### PETROMYZONTIDAE

*Entosphenus japonicus* (Martens)

### SQUALIDAE

1 (2) Dorsal fins with spines. Caudal fin without subterminal notch. Teeth similar in both jaws. Maximum length about 4 feet.

*Squalus acanthias* Linnaeus – spiny dogfish

2 (1) Dorsal fins without spines. Caudal fin with subterminal notch. Teeth dissimilar in upper and lower jaws. Maximum length about 20 feet.

*Somniosus microcephalus* (Bloch and Schneider) – sleeper shark

### RAJIDAE

1 (2) Mid-dorsal spines 23 to 31. Interorbital space wide, more than double the eye diameter. Undersurface usually white with dark markings.

*Raja hyperborea* Collett

2 (1) Mid-dorsal spines 11 to 19. Interorbital space narrow, less than twice the eye diameter. Under surface usually white.

*Raja radiata* Donovan – Atlantic prickly skate

### CLUPEIDAE

*Clupea harengus* Linnaeus – herring

### SALMONIDAE

1 (14) Strong teeth in jaws; jaws extend back to or past centre of eye. Lateral line scales numerous, 109 or more. Body or fins usually with dark markings.

(Salmoninae)

2 (7) Anal rays 13 to 19; 19 to 40 gill rakers. Dorsal fin without spots.

*(Oncorhynchus)*

3 (4) Large spots (nearly eye size) on back and tail; 170 to 229 scales on first row above lateral line.

*Oncorhynchus gorbuscha* (Walbaum) – pink salmon

4 (3) No large spots on back and tail; 125 to 155 scales on first row above lateral line.

5 (6) Gill rakers 20 to 26. Pyloric cacae 140 to 185.

*Oncorhynchus keta* (Walbaum) – chum salmon

6 (5) Gill rakers 30 to 39. Pyloric cacae 66 to 92. (Arctic record questionable).

*Oncorhynchus nerka* (Walbaum) – sockeye salmon

7 (2) Anal rays 7 to 12; 20 or fewer gill rakers; dorsal fin usually with spots.

8 (9) Body silver with small black crosses on back. Weak teeth on shaft of vomer; 111 to 118 scales in oblique rows.

*Salmo salar* Linnaeus – Atlantic salmon

9 (8) Body dark with light or coloured spots. No teeth on shaft of vomer; 150 to 250 oblique scale rows.

*(Salvelinus)*

10 (11) Tail deeply forked. Without coloured spots. Pyloric cacae 90 to 170. Small pearl organs on scales at spawning time.

*Salvelinus namaycush* (Walbaum) – lake char

11 (10) Tail square or emarginate. Orange, red, or blue spots. Pyloric cacae 15 to 65. No pearl organs at spawning time.

12 (13) Dorsal fin with dark marks; red spots haloed with blue on sides. Basibranchial teeth less than eight, usually none.

*Salvelinus fontinalis* (Mitchill) – brook char

13 (12) Dorsal fin without dark marks; spots on side red or yellow without blue halo. Two or more rows of basibranchial teeth.

*Salvelinus alpinus* (Linnaeus) – arctic char

14 (1) Teeth in jaws weak or absent. Jaw not extending to middle of eye (except *Stenodus*). Lateral line scales less than 108. Body usually

silver, fins without spots.

(Coregoninae)

15 (16) Maxillary extending past pupil. Numerous very fine brushlike teeth in jaws and on tongue, vomer, and palatines.

*Stenodus leucichthys* (Güldenstadt) – inconnu

16 (15) Maxillary not extending past pupil. Teeth usually absent or very few.

17 (18) One nasal flap; juveniles with parr marks. Anal rays 11 to 13. Gill rakers 14 to 20.

*Prosopium cylindraceum* (Pallas) – round whitefish

18 (17) Two nasal flaps; juveniles without parr marks. Anal rays 13 to 16. Gill rakers 17 to 58.

*(Coregonus)*

19 (22) Gill rakers 33 or fewer; premaxillaries usually retrorse or vertical.

20 (21) Gill rakers 24 to 33; longest gill raker less than 70 times in standard length.

*Coregonus clupeaformis* (Mitchill) – lake whitefish

21 (20) Gill rakers 19 to 25; longest gill raker 75 to 100 times in standard length.

*Coregonus nasus* (Pallas) – broad whitefish

22 (19) Gill rakers 33 or more; premaxillaries usually antrorse.

23 (24) Tip of lower jaw in front of tip of upper jaw when mouth closed. Tips of pectoral, pelvic and anal fins black.

*Coregonus albula* (Linnaeus) – least cisco

24 (23) Tip of lower jaw behind or even with tip of upper jaw when mouth closed. Fins light coloured.

*Coregonus oxyrhynchus* (Linnaeus) – lauretta herring

## OSMERIDAE

1 (4) Base of adipose fin equal to or shorter than eye diameter. Anal fin rays 11 to 16. Peritoneum silver.

2 (3) Large fangs on tongue. Lower jaw with frenum. Lateral line scales 65 to 72.

*Osmerus eperlanus* Linnaeus – arctic smelt

3 (2) Large fangs on tongue lacking. Lower jaw without frenum. Lateral line scales 53 to 62.

*Hypomesus olidus* (Pallas) – pond smelt

4 (1) Base of adipose fin longer than eye diameter. Anal rays 16 to 19. Peritoneum black.

*Mallotus villosus* (Müller) – capelin

## GONOSTOMIDAE

*Cyclothone microdon* (Günther)

## SUDIDAE

*Paralepis rissoi* Bonaparte

## MYCTOPHIDAE

1 (2) Length of pectoral fin equal to head length. Eye diameter enters more than twice into maxilla length. Anal with 15 or fewer rays.

*Lampanyctus crocodilus* (Risso)

2 (1) Length of pectoral fin less than head length. Eye diameter less than twice maxilla length. Anal with 16 or more rays.

*Benthosema glaciale* (Reinhardt) – glacial lanternfish

## SACCOPHARYNGIDAE

*Saccopharynx ampullaceus* (Harwood)

SYNAPHOBRANCHIDAE

*Synaphobranchus kaupii* Johnson

GADIDAE

1 (6) Two dorsal fins; one anal fin (Lotinae)

2 (3) First ray of first dorsal fin not longer than the other rays. Base of second dorsal fin less than one-half the standard length.

*Lota lota* (Linnaeus) – burbot

3 (2) First dorsal fin consisting of one long ray followed by many short ones. Second dorsal fin exceeds one-half the standard length.

*(Gaidropsarus)*

4 (5) First dorsal ray much shorter than the head length. Head length enters fewer than 5.5 times in standard length.

*Gaidropsarus argentatus* (Reinhardt)

5 (4) First dorsal ray about as long as head. Head length enters 5.5 times or more in standard length.

*Gaidropsarus ensis* (Reinhardt)

6 (1) Three dorsal fins and two anal fins.

(Gadinae)

7 (8) First anal fin long, with 25 to 30 rays.

*Pollachius virens* (Linnaeus) – pollack

8 (7) First anal fin short with 24 or fewer rays.

9 (12) Gill rakers 31 or more.

10 (11) Lateral line with four curves. Gill rakers 37 to 45. No palatine teeth.

*Boreogadus saida* (Lepechin) – arctic cod

11 (10) Lateral line with one curve. Gill rakers 32 to 34. Palatine teeth present.

*Arctogadus pearyi* (Nichols and Maxwell)

12 (9) Gill rakers 30 or fewer.

13 (14) Filament on pelvic fin about as long as rest of fin. No sensory pores on head. Last half of lateral line interrupted.

*Elginus navaga* (Pallas) – saffron cod

14 (13) Filament on pelvic fin less than half the length of rest of pelvic fin. With sensory pores on head. Last one-third or less of lateral line interrupted.

15 (16) Lateral line white. Barbel length less than eye diameter. Interorbital space less than one-quarter the head length.

*Gadus morhua* Linnaeus – cod

16 (15) Lateral line blotched. Barbel length exceeds eye diameter. Interorbital space exceeds one-quarter head length.

*Gadus ogac* Richardson – ogac

## MACROURIDAE

1 (2) Premaxillary teeth in one band, none enlarged. Scales with serrate median keel. About 19 long pyloric cacae.

*Macrourus berglax* Lacepede – rough-head grenadier

2 (1) Premaxillary teeth in two bands, those in outer series enlarged. Scales ctenoid, lacking keel. About 11 thick pyloric cacae.

*Nematonurus armatus* (Hector)

## GASTEROSTEIDAE

1 (2) Dorsal spines long, higher than dorsal fin. Usually three (rarely two to five) dorsal spines. Anal spine under dorsal fin. Plates behind pectoral fin.

*Gasterosteus aculeatus* Linnaeus – threespine stickleback

2 (1) Dorsal spines shorter than dorsal fin. Usually more than five (rarely four) dorsal spines. Anal spine anterior to or below origin of dorsal fin. No plates behind pectoral fin.

3 (4) Dorsal spines five to six (rarely four). Anal spine in front of dorsal fin. No keel on side of caudal peduncle.

*Eucalia inconstans* (Kirtland) – brook stickleback

4 (3) Dorsal spines 8 to 10 (rarely 7 to 12). Anal spine below origin of dorsal fin. Keel on side of caudal peduncle.
*Pungitius pungitius* (Linnaeus) – ninespine stickleback

ANARHICHADIDAE

*Anarhichas denticulatus* Krøyer – wolf-fish

STICHAEIDAE

1 (4) Dorsal spines less than 52, anal rays 37 or less (excluding spines). Body compressed.

2 (3) Four lateral lines. Anal fin with 29 to 32 rays, pectoral with 17 to 18 rays.
*Eumesogrammus praecisus* (Krøyer) – fourline snakeblenny

3 (2) One lateral line (incomplete). Anal fin with 32 to 37 rays; pectoral with 15 to 16 rays.
*Stichaeus punctatus* (Fabricius) – spotted snakeblenny

4 (1) Dorsal spines more than 56, anal rays 37 or more (excluding spines). Body round in cross-section.

5 (8) Vomerine teeth absent. Tips of lower pectoral rays not free from the membrane.
*(Lumpenus)*

6 (7) Pectoral rays 13 to 14 (rarely up to 15). Membranes of dorsal and anal fins joined to caudal fin. Gill openings extend to below eyes. Dorsal 58 to 63. Anal higher posteriorly.
*Lumpenus medius* (Reinhardt) – stout eelblenny

7 (6) Pectoral rays 15 to 17. Membranes of dorsal and anal fins not joined to caudal fin. Gill openings do not extend as far forward as below the eyes. Dorsal (61) 63 to 66. Anal of even height.
*Lumpenus fabricii* Reinhardt – slender eelblenny

8 (5) Vomerine teeth present. Tips of lower pectoral rays free from membrane.
*Leptoclinus maculatus* (Fries)

## PHOLIDAE

*Pholis fasciata* (Bloch and Schneider)
(with or without pelvics)

## ZOARCIDAE

Dorsal and anal fin ray counts include one-half the caudal fin rays.

1 (4) Pelvic fins absent. Snout does not overhang mouth (Gymnelinae).

2 (3) Lower jaw protrudes. Dorsal rays about 50, anal rays about 45.
*Lycocara parrii* (Ross)

3 (2) Jaws equal. Dorsal rays about 90 or more, anal rays about 70 or more.
*Gymnelis viridus* (Fabricius)

4 (1) Pelvics present; snout overhangs mouth (Lycodinae)

5 (8) Sides of body well scaled, including anterior to vertical through posterior tip of pectoral fin.

6 (7) Two lateral lines present. Anal with 79 to 86 rays.
*Lycodes pallidus* Collett – pale eelpout

7 (6) One lateral line. Anal with 78 or fewer rays.
*Lycodes reticulatus* Reinhardt – arctic eelpout

8 (5) Scales absent from sides or very poorly developed, never scaled anterior to vertical through posterior tip of pectoral fin.

9 (10) Posteriormost premaxillary tooth lies at the level of the last vomerine or first palatine tooth. Length of premaxillary band of teeth equal one-half mandibular band.
*Lycodes turneri* Bean – polar eelpout

10 (9) Posteriormost premaxillary tooth lies just anterior to the last palatine tooth. Length of premaxillary band = mandibular band.
*Lycodes mucosus* Richardson

## AMMODYTIDAE

1 (2) Anal rays 28 to 31; dorsal rays 57 to 60. Vertebrae 64 to 69.
*Ammodytes hexapterus* Pallas – arctic sandlance

2 (1) Anal rays 32 to 35; dorsal rays 62 to 67. Vertebrae 71 to 75.
*Ammodytes dubius* Reinhardt – dubius sandlance

## SCORPAENIDAE

*Sebastes marinus* (Linnaeus) – rosefish

## COTTIDAE

1 (6) With palatine teeth.

2 (5) Upper preopercular spine bifurcate, sometimes trifurcate, not strongly hooked. Row of spiny bony plates above lateral line.
*(Icelus)*

3 (4) Lateral line usually incomplete; lateral line plates with tiny spines below the pores. Tip on end of urogenital papilla of male longer than depth of caudal peduncle, not at right angles to base.
*Icelus bicornis* (Reinhardt)

4 (3) Lateral line usually complete; lateral line plates without tiny spines below pores. Tip on end of urogenital papilla of male at right angles to base and shorter than the depth of the caudal peduncle.
*Icelus spatula* Gilbert and Burke

5 (2) Upper preopercular spine simple, strongly hooked. Skin naked above lateral line.
*Artediellus uncinatus* (Reinhardt) – hookear sculpin

6 (1) Palatine teeth absent.

7 (14) Upper preopercular spine without spinules; vomer with teeth.

8 (19) Skin below lateral line not in folds; anal rays less than 20.

9 (22) Gill membranes not joined to wide isthmus; second preopercular spine pointing backward.

*(Myoxocephalus)*

10 (11) Four preopercular spines; usually large rough-topped spines above eye and on occiput in adults. Lateral line usually incomplete. Mandibular pores almost invisible.

*Myoxocephalus quadricornis* (Linnaeus) – fourhorn sculpin

11 (10) Three preopercular spines (rarely four); if spines above eye and on occiput, never large and rough-topped. Lateral line usually complete. With visible mandibular pores.

12 (13) Pectoral rays 17 to 18 (rarely 16). Frontal and parietal spines develop stout accessory spines at bases. Straight portion 1.1 on c.p. exceeds eye diameter. No or weak cirri on head spine.

*Myoxocephalus scorpius* (Linnaeus) – shorthorn sculpin

13 (12) Pectoral rays 14 to 16. Frontal and parietal spines incipient and lack accessory spines at their bases. Straight portion 1.1 on c.p. less than eye diameter. Stout cirri on head spines.

*Myoxocephalus scorpiodes* (Fabricius) – false seascorpion

14 (7) Uppermost preopercular spine with spinules. Vomer without teeth.

(Gymnocanthus)

15 (16) Lateral line pores 45 to 48. Orbital rims with rough bony plates.

*Gymnocanthus galeatus* Bean

16 (15) Lateral line pores 34 to 43. Orbital rims free from rough bony plates.

17 (18) No blunted spine behind each frontal spine. Males without club-shaped filiaments in axillary region.

*Gymnocanthus tricuspis* (Reinhardt) – staghorn sculpin

18 (17) Three blunt spines behind frontal spines. Males with club-shaped filiaments in axillary region.

*Gymnocanthus pistilliger* (Pallas)

19 (8) Skin below lateral line in folds; anal rays 20 or more.

20 (21) Pectoral rays 20 to 22; diameter of orbit exceeds snout. Middle pelvic ray longest.

*Triglops nybelini* Jensen – mailed sculpin

21 (20) Pectoral rays 16 to 19; diameter of orbit = snout. Inner pelvic ray longest.

*Triglops pingelii* Reinhardt – ribbed sculpin

22 (9) Gill membranes joined to wide isthmus; second preopercular spine (skin covered) points downward.

*Cottus cognatus* Richardson – slimy sculpin

## AGONIDAE

1 (4) One dorsal fin. One or no barbels at corner of mouth.

2 (3) About 9 to 10 pectoral rays; dorsal plates 46 to 48.

*Aspidophoroides monopterygius* (Bloch) – alligatorfish

3 (2) Pectoral rays 13 to 16; dorsal plates 33 to 40.

*Aspidophoroides olrikii* Lütken – arctic seapoacher

4 (1) Two dorsal fins. Several barbels at corner of mouth.

5 (6) No cirri on underside of snout. Lateral line pores 23 to 30. Pectoral with 14 to 16 rays.

*Leptagonus decagonus* (Bloch and Schneider)

6 (5) Cirri on underside of snout. Lateral line pores 37 to 40. Pectoral with 17 to 18 rays.

*Agonus acipenserinus* Tilesius – sturgeon-like seapoacher

## CYCLOPTERIDAE

1 (6) Two short dorsal fins (first may be encased in skin); usually large tubercles imbedded in skin; dorsal and anal fins separated from caudal fin; anal fin with less than 20 rays.

(Cyclopterinae)

2 (3) Gill opening large, extending below top of pectoral fin base.

*Cyclopterus lumpus* Linnaeus – lumpfish

3 (2) Gill opening small, not extending below top of pectoral fin base.

4 (5) Tubercles absent from chin and usually from pectoral base. Chin without barbels; no tubercles on body in contact with base of first dorsal.

*Eumicrotremus derjugini* Popov – leatherfin lumpsucker

5 (4) Tubercles present on chin and pectoral fin base. Chin with barbels. Tubercles on body in contact with base of first dorsal fin. Between dorsals one pair of tubercles.

*Eumicrotremus spinosus* (Fabricius) – spiny lumpsucker

6 (1) One long dorsal. No large tubercles on skin. Dorsal and anal fins usually in contact with caudal fin. Anal fin with more than 20 rays.

(Liparinae)

7 (18) Sucking disc present.

8 (9) Peritoneum black; anal rays 37 to 41.

*Liparis koefoedi* Parr – gelatinous seasnail

9 (8) Peritoneum not black; anal with 37 rays or fewer.

10 (15) Anal rays more than 32; dorsal rays 40 or more.

11 (12) Pectoral rays 39 to 43; gill slit extending down in front of more than 10 pectoral rays.

*Liparis cyclostigma* Gilbert

12 (11) Pectoral rays 35 to 38; gill slit extending down in front of six or fewer rays.

13 (14) Pyloric cacae 30 or more; gill opening in front of three to six pectoral rays.

*Liparis tunicatus* Reinhardt

14 (13) Pyloric cacae 20 or fewer; gill opening extending down in front of three or less rays of the pectoral fin.

*Liparis herschelinus* Scofield

15 (10) Anal rays less than 31; dorsal rays less than 40.

16 (17) Pectoral rays 26 to 28; dorsal rays 32 to 35; 19 to 37 pyloric cacae.

*Liparis atlanticus* (Jordan and Evermann)

17 (16) Pectoral rays 32 to 33; dorsal rays 34 to 35; 10 to 13 pyloric cacae.

*Liparis liparis* (Linnaeus)

18 (7) Sucking disc absent.

19 (22) Gill slit reduced to a pore above the pectoral fin. Lowest rays of fin shorter than head.

20 (21) Upper lobe of pectoral with about 13 rays. Whole body a brown-black.

*Paraliparis bathybii* Collett

21 (20) Upper lobe of pectoral with about 17 rays. Anterior of body pale, posterior brown.

*Paraliparis copei* Goode and Bean

22 (19) Gill slit not reduced to a pore extending down in front of the pectoral fin. Lowest rays of pectoral fin filamentous, longer than head (resemble pelvic rays).

*Rhodichthys regina* Collett

PLEURONECTIDAE

1 (2) Long jaws extending past middle of eye, length less than three times in head length. Anal rays 71 to 76.

*Reinhardtius hippoglossoides* (Walbaum) – Greenland halibut

2 (1) Short jaws, not extending past middle of eye, length more than three times in head length. Anal rays 35 to 46.

3 (4) Bony tubercles scattered on sides. Dark bars on dorsal and anal fins.

*Platichthys stellatus* (Pallas) – starry flounder

4 (3) No bony tubercles on sides. No dark bars on dorsal and anal fins.

*(Liopsetta)*

5 (6) Head 3⅓ to 3⅘ times in length; pectoral two times in head in males, shorter in females.

*Liopsetta glacialis* (Pallas)

6 (5) Head 3⅙ to 3¼ times in length; pectoral 1½ times head in males, shorter in females.

*Liopsetta putnami* (Gill) – smooth flounder

## Glossary

Fig. 1. A–Hypothetical salmonid, B–Hypothetical cottid, C–Mouth of fish showing teeth.

1, maxillary; 2, isthmus; 3, frontal spine; 4, preopercular spine; 5, parietal spine; 6, pelvic fin; 7, pectoral fin; 8, dorsal fin; 9, fleshy appendage; 10, first dorsal fin; 11, urogenital papilla; 12, second dorsal fin; 13, anal fin; 14, lateral line; 15, adipose fin; 16, caudal fin; 17, vomer; 18, palatine; 19, shaft of vomer; 20, basibranchial teeth; 21, premaxillary teeth; 22, maxillary teeth.

NOTE. The numbers in parentheses after the definitions refer to the above figure.

*Adipose fin.* Fleshy rayless fin on the back between dorsal and caudal fins (15).

*Anal fin.* Fin on lower surface of body behind the anus (13).

*Antrorse.* Inclined forwards.

*Barbel.* Filament-like appendage near the mouth.

*Bifurcate.* Forking into two.

*Bilobed.* In two lobes.

*Caudal fin.* Tail fin (16).

*Caudal peduncle.* Wrist-like region between the anal fin and the tail fin.

*Cirri.* Fleshy projections not around the mouth.

*Ctenoid.* Rough scales with small spines.

*Dorsal fin.* A fin on the midline of the back (8, 10, 12).

*Fleshy appendage.* Triangular appendage at the base of the pelvic fin (9).

*Frenum.* Tissue fusing the lip to the jaw.

*Frontal spine.* Spine erupting from the frontal bone (roof bone of skull behind eye) (3).

*Gill membranes.* Membrane joining the gill cover to the lower surface of the head.

*Gill raker.* Short or elongate protuberances on the inner surface of the arch bearing the gill.

*Interorbital space.* Space between the eyes.

*Isthmus.* Ridge on lower surface of head between the gills (2).

*Lateral line.* Tube-like sensory structure running along the side of the body and on the head. The tube communicates with the surface by means of pores, which usually pierce the scales (14).

*Mandibular pores.* Lateral line pores on the undersurface of the lower jaw.

*Maxillary.* The upper jaw bone (22).

*Palatine.* Bone, often bearing teeth, lateral to the vomer (18).

*Parietal spine.* Spine erupting from the parietal bone (dorso-lateral surface of back end of the head) (5).

*Pearl organs.* Small conical cornified protusions on the skin formed at spawning time.

*Pectoral fin.* Paired fin immediately behind the gill slit (7).

*Pelvic fin.* Paired fin either behind the pectoral fin or below it (6).

*Peritoneum.* Lining of the abdominal cavity which contains the intestines.

*Photophore.* Small organ on the skin capable of giving off light (see circular organs on figure of Myctophidae).

*Placoid scales.* Small tooth-like scales on the skin of sharks and rays.

*Premaxillary teeth.* Teeth on front portion of upper jaw (21).

*Preopercular spine.* Spine on the "cheek" bone in front of the gill cover (4).

*Pseudobranch.* Small gill attached to the inside of the gill cover.

*Pyloric cacae.* Small outpocketings of the intestine behind the stomach.

*Retrorse.* Inclined backwards.

*Serrate.* Toothed like a saw.

*Standard length.* Length between the most anterior point on the body and the base of the tail fin.

*Trifurcate.* Forking into three.

*Tubercles.* Bony plates or lumps, often spiny, on the skin.

*Urogenital papilla.* Fleshy appendage erupting from behind the anus enclosing the urogenital duct (11).

*Vomer.* Bone, often bearing teeth, on the centre of the roof of the mouth (17); shaft of the vomer is the posterior extension of this bone (19).

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OTTAWA, 1960

Cat. No. R95–5/5

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Natural History Papers

National Museum of Canada

DEPARTMENT OF NORTHERN AFFAIRS
AND NATIONAL RESOURCES

OTTAWA

NUMBER 6 JUNE 2 1960

# SOME NOTEWORTHY ACCESSIONS TO THE NATIONAL MUSEUM MAMMAL COLLECTION

A. W. F. Banfield

During the course of cataloguing recent accessions to the National Museum of Canada mammal collection, some interesting range extensions and other occurrences of Canadian mammals were disclosed that merit recording.

**Condylura c. cristata** (Linnaeus). A dead star-nosed mole was picked up at Little Whale River, 56° N. 77° W., on the eastern side of Hudson Bay, northern Quebec, in August, 1959, by Mr. G. Falconer, of the Geographical Branch, Department of Mines and Technical Surveys, Ottawa. The specimen, number 25645, which the collector donated to the National Museum on October 19, 1959, consisted of a flat skin of unknown sex, without skull. This specimen extends the known range about 250 miles northward to within about 100 miles of the tree-line. Other specimens have been taken at Lake Mistassini and at Eastmain, Quebec.

**Sorex vagrans obscurus** Merriam. An excellent collection of *Sorex arcticus tundrensis* and *Sorex cinereus ugyunak* was made by T. H. Manning and A. H. MacPherson at Tuktoyaktuk, Mackenzie Delta, N.W.T., during the autumn of 1952. Among those shrews was one specimen of the captionally mentioned species. It is an adult male, number 24352, taken by Mr. MacPherson on November 22, 1952, consisting of skin and skull. The latter clearly shows the diagnostic third unicuspid tooth smaller than the fourth. Although the specimen extends the species' known range to the Arctic coast of Canada for the first time, its presence in the Brooks Range of Alaska makes its occurrence not entirely unexpected.

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**Citellus c. columbianus** (Ord). Mr. Bernard Hamm donated two flat skins of the Columbian ground squirrel which he captured near Wembley, Peace River district, Alberta, in the spring of 1951. The specimens are numbers 24337 and 24344 of the collection. The farmlands of the Peace River plateau have been unique among prairie agricultural areas in the absence of ground squirrels of the genus *Citellus*. These specimens extend the known range of the Columbian ground squirrel from the Smoky River valley of the Rocky Mountains to the edge of the agriculturally developed lands. It is yet to be determined if the species will spread into the farmlands, as it has done in the southern foothills near Pincher Creek, Alberta.

**Microtus miurus cantator** Anderson. The Yukon singing mouse was described by R. M. Anderson (1946), based upon two specimens from Tepee Lake, Kluane Game Sanctuary, Y. T., which were shot by C. H. D. Clarke as they appeared at their burrow entrances in 1943. The specimens were somewhat mutilated juveniles, and Anderson gave the new form full specific rank.

It was later referred to the Alaskan species *miurus*, and specimens from eastern Alaska were assigned to the present subspecies. However the study of the group was handicapped by the lack of topotypes.

During the course of cataloguing some smaller collections of mammals, a lone adult female of *Microtus miurus* (L. 128, T. 24, H.F. 18) was discovered, collected by I. V. F. Allen at the head of Kluane Lake on July 11, 1949, while on a National Museum expedition led by W. E. Godfrey. It was catalogued as number 24275. A re-examination of the *Microtus* specimens collected on the expedition disclosed a misidentified *miurus*, number 20246, adult male (L. 147, T. 22, H.F. 17) collected by Allen at the same locality on July 10. This species should therefore be added to Cameron's (1952) list of species recorded on the expedition.

The value of the new specimens lies in their being not only topotypes of *cantator* but also the first representative adults.

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# Natural History Papers

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DEPARTMENT OF NORTHERN AFFAIRS
AND NATIONAL RESOURCES

OTTAWA

NUMBER 7 JUNE 13 1960


# A GIANT ULTRA-ABYSSAL *Cocculina* (MOLLUSCA, GASTROPODA) FROM THE ARGENTINE BASIN

ARTHUR H. CLARKE, JR.

## INTRODUCTION

On March 28, 1959, scientists aboard the R/V *Vema*[1] dredged a remarkable new species of *Cocculina* from the southern end of the Argentine Basin. Although only one specimen was taken, the find is significant in that (1) it exceeds by nearly 1,000 fathoms the next deepest record for a species of the superfamily Cocculinacea[2]; (2) it is the first record of the superfamily from the ultra-abyssal or hadal zone of the ocean; (3) it is the first cocculinid from the western half of the South Atlantic Ocean; and (4) it is the largest specimen of the superfamily on record.

A compilation from the literature shows that 54 superfamilies (or equivalent groups) of molluscs have been validly recorded from depths exceeding 1,000 fathoms, taken here as the beginning of the abyssal or deep-sea zone. If we consider as typical of the deep sea only the 27 superfamilies with ten or more abyssal species, the Cocculinacea rank first among the gastropods and second only to the bivalve family Isocardiacea within the molluscs as a whole with respect to specific endemism. Of the twelve abyssal cocculinid species known, ten have been recorded, each from only a single ocean basin, and two are known from only two basins. In each of the latter cases, the two basins are contiguous.

Such extreme endemism correlates, perhaps significantly, with the apparent geologic age of the group. Fossils of the Cocculinacea have been found in deposits dating back only to the Tertiary (Knight, 1952), and except for the Octopodacea, which has no fossil record, it is apparently the youngest of the typically abyssal mollusc superfamilies. Fossils of such a rather rare deep-sea group must be expected to occur infrequently however, and the Cocculinacea may have evolved somewhat earlier.

[1] Owned and operated by the Lamont Geological Observatory, Columbia University, Palisades, New York.

[2] *Cocculina maxima* Dautzenberg 1925, dredged from 4,275 metres (2,339 fathoms) near the Azores.

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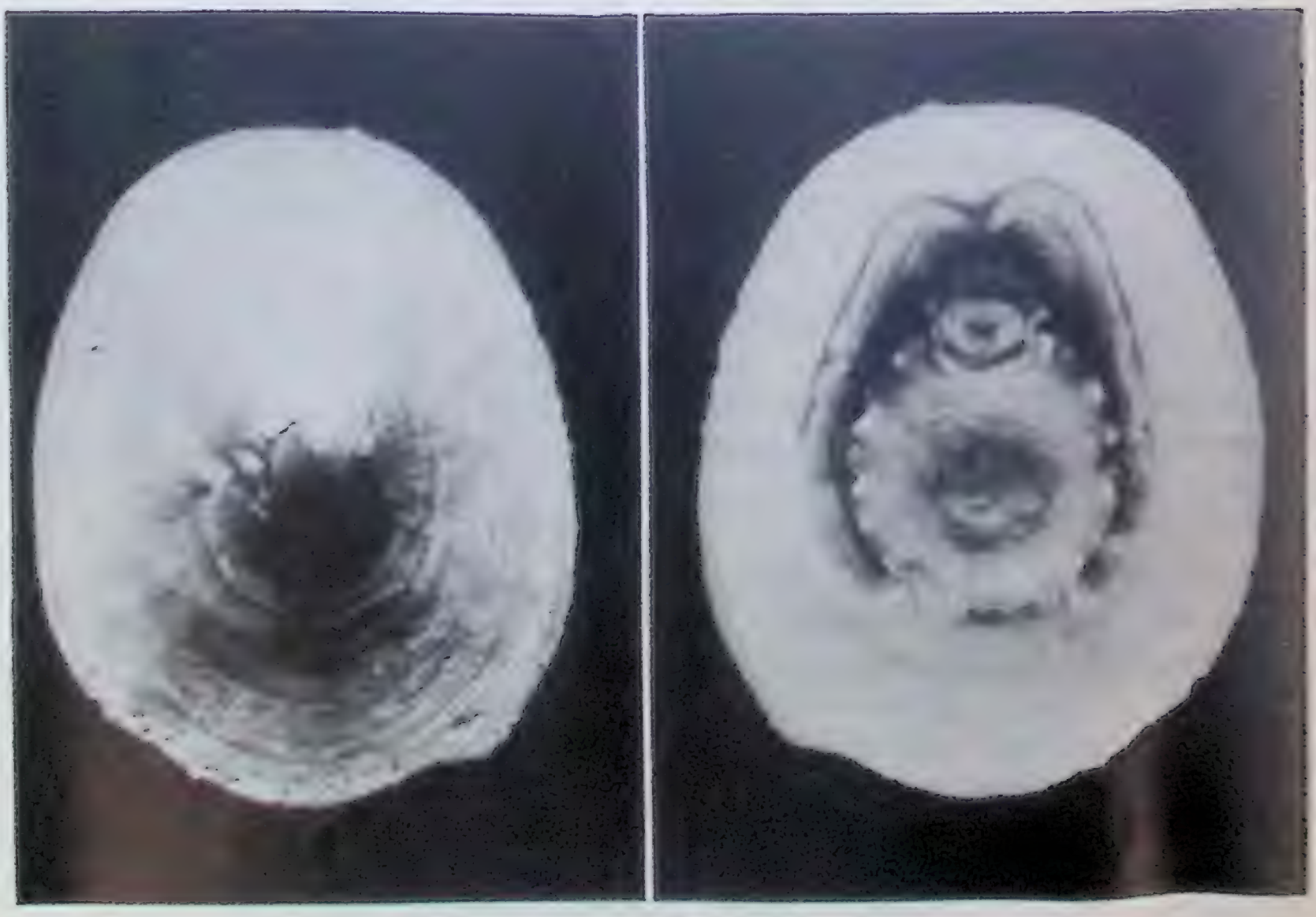
Absence of the pelagic larval stage in deep-sea molluscs has been suggested to be an important element contributing to the apparent endemism of abyssal mollusc species (Clarke, 1959). Another significant factor must be the relative mobility of adults. Presumably, cocculinids are sluggish and have low mobility and very restricted gene flow between populations, hence high specific endemism.

Parenthetically, it is interesting to speculate briefly on the effect of this factor in delimiting the distribution of abyssal molluscs as a whole. Studies presently underway by the author indicate that among the abyssal molluscs only the cephalopods contain species which have a cosmopolitan distribution. Many abyssal cephalopods resemble deep-sea fish in their wide distribution and active, bathypelagic mode of life. Among the other abyssal molluscs, the superfamilies which contain the most widely distributed species are, in general, either the groups with continuous fossil history dating back to the early Palæozoic or groups in which adults exhibit high mobility.

ACKNOWLEDGMENTS

The author is grateful to Dr. Maurice Ewing, Director of the Lamont Geological Observatory, for permission to describe this species, and to Dr. Harald A. Rehder and Dr. Robert Robertson for their efforts to locate the specimen of *Cocculina rathbuni* Dall cited below.



## Cocculina superba, new species

*Description.* Shell patelliform, large, white to greyish white, weakly sculptured and of medium thickness. Apex elevated, deciduous, centrally located, and directed posteriorly. Shell convex anteriorly and somewhat concave posteriorly. Aperture sub-ovate and narrower anteriorly. Sculpture consisting of numerous, irregular lines of growth, and more numerous, less well-defined radial threads. About twelve concentric lines more prominent and evenly spaced between apex and margin. Radial threads low, crowded, and numbering about 140.

The animal, first preserved in formalin and later in alcohol, is 21 mm long, 16 mm wide, and light yellowish in colour. The head, which is 5.8 mm long and 5.5 mm wide, bears on its ventral surface a large, muscular, posteriorly directed proboscis measuring 2.8 mm and 3.5 mm across the ovate distal end. One tapering, recurved, ventrally directed tentacle, about 3.0 mm long, is present on each side of, and above, the proboscis. The intromittent organ projects from the visceral mass on the right side of the animal adjacent to the base of the head. Contracted in preservative, it is tapered, concentrically wrinkled, 1.0 mm in basal diameter, and 3.0 mm in length. The short anal papilla lies at the left of the intromittent organ and a little in front of it. The foot is muscular, with a crenulated edge, flattened, and nearly circular except anteriorly, where it is bent ventrally by the muzzle. It measures approximately 12.8 mm in length and 12.1 mm in width. The mantle is appressed to the shell and surrounds the head and the foot.

| length | width | height | |
|---|---|---|---|
| 32* | 26 | 9 mm | holotype |

*Types.* The holotype, a unique specimen, was collected on March 28, 1959, at R/V *Vema* biology station 210: latitude 47° 57.5' S., longitude 48° 03' W., and 3,334 fathoms depth (corrected) in the Argentine Basin, approximately 800 miles east of Deseado, Argentina. It is now at the Lamont Geological Observatory, Palisades, New York.

*Remarks.* In shell characters, C. *superba* is quite different from all previously described species of *Cocculina*. C. *maxima* Dautzenberg is differently shaped and proportionately much higher (23 mm long, 16½ mm wide, and 16½ mm high). C. *rathbuni* Dall has flattened sides, is narrower and more depressed, and the apex is less conspicuously tilted. The other species are all very small and differ in a number of characters.

Under C. *rathbuni* Dall, Pilsbry (1890: 132) states: "Length 11, breadth 6.5, height 2.75 mill. Another dead specimen is three times larger." Apparently this larger specimen is not at the United States National Museum nor at the Philadelphia Academy of Natural Sciences and must be presumed lost. If Pilsbry's casual statement may be taken literally, C. *rathbuni* shares with C. *superba* the distinction of being the longest species of

* One mm chipped away posteriorly.

*Cocculina* (33 mm), although *superba* is wider and higher. Of course the maximum size attained by these species is indeterminate at the present time.

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Cat. No. R95–5/7

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DEPARTMENT OF NORTHERN AFFAIRS
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OTTAWA

NUMBER 8 AUGUST 30 1960

# THE SURVIVAL OF THE WOOD BISON (*BISON BISON ATHABASCAE* RHOADS) IN THE NORTHWEST TERRITORIES

A.W.F. BANFIELD[1] AND N.S. NOVAKOWSKI[2]

Samuel Hearne (1795) was the first European to see the wood bison in its natural haunts on Great Slave Lake on January 9, 1772. Later explorers failed to notice the differences between the northern and the plains bison. Hind (1860) and Seton (1886) were the first writers to suggest the existence of a northern race, but it was Rhoads (1897) who finally described the northern race for science, based upon a bull, shot by Warburton Pike in 1890. The type specimen is preserved in the National Museum of Canada. The race was recognized by its large size and dark woolly pelage.

About the beginning of the nineteenth century the range of the wood bison extended throughout the aspen parkland of central Saskatchewan and Alberta (roughly north of the North Saskatchewan River), through the coniferous forests to Lac la Martre and the Horn Mountains in the Northwest Territories. The range extended westward including the valleys of the Liard and Peace rivers to the eastern slopes of the Rocky Mountains. In the Rockies the range swept southward to Colorado (Skinner and Kaisen, 1947).

Heavy exploitation of the northern herds followed the virtual extinction of the southern herds of plains bison *(Bison bison bison)*. The northern herds commenced to dwindle in the Rocky Mountains and aspen parkland by 1860. The pace of extirpation increased, and they were practically extinct south of the Peace River by 1875. By 1891 they were reduced to about 300 animals in a wilderness stronghold south of Great Slave Lake and west of the Slave River (Ogilvie, 1893). That year a law providing protection for

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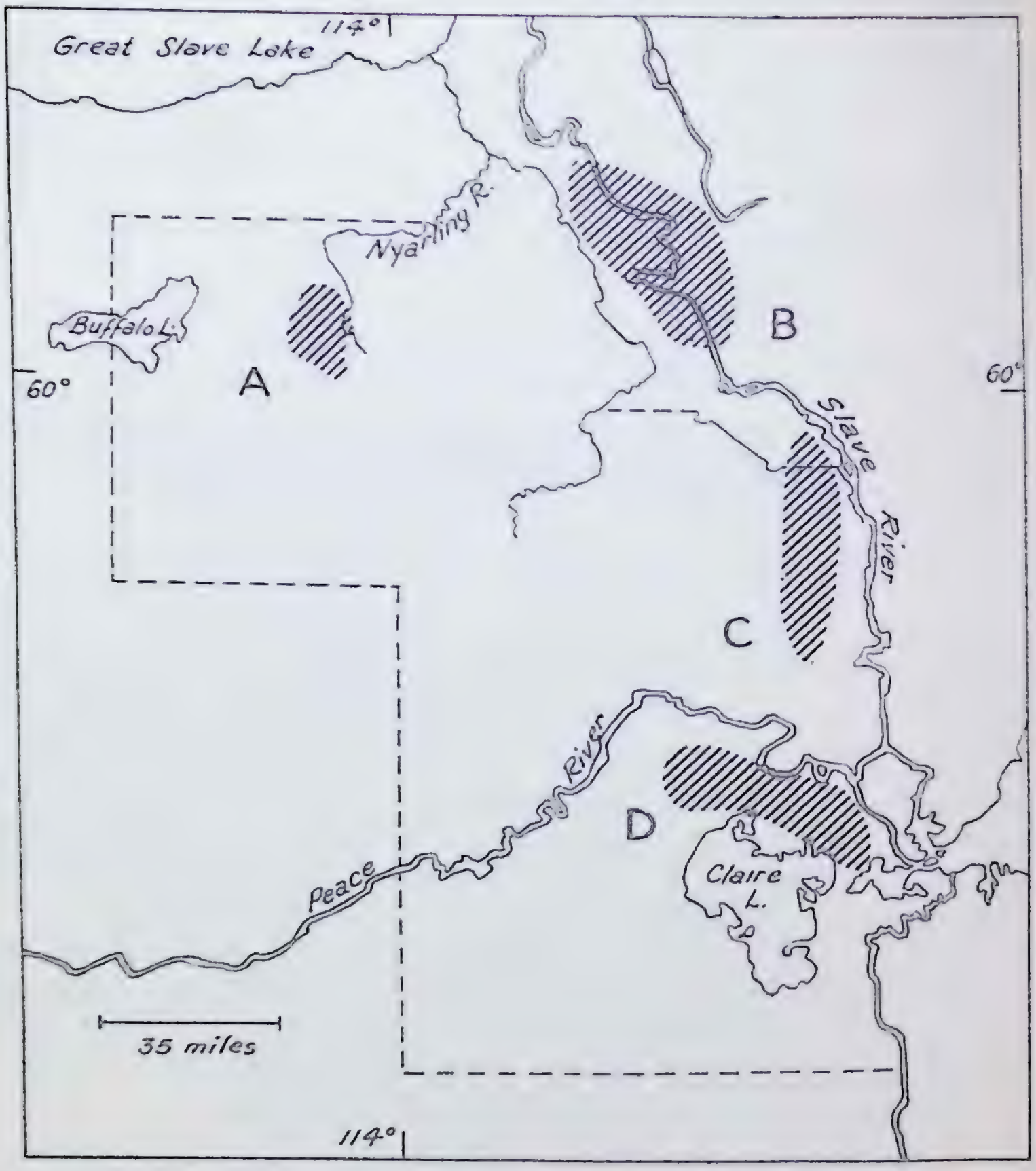


Figure 1. Location of main bison herds in and near Wood Buffalo Park.
A - Nyarling herd; B - Grand Detour Herd; C - Hay Camp herd;
D - Lake Claire herd.

the survivors was passed by the Federal Government.

The bison were not slow to respond to the protection, and by 1914 the population was estimated by Harper (1932) to have increased to approximately 500. When Wood Buffalo Park was established in 1922, the population was estimated by Seibert (1923) to have reached 1,500 to 2,000 animals.

A new chapter in the history of the wood bison commenced in 1925, when the Federal Government introduced the first young plains buffalo from Wainwright Buffalo Park, Alberta. That herd had been built up from the Allard-Pablo herd purchased in Montana in 1906. As the bison, by their

increase, had become overcrowded on their restricted range, it was decided to ship young stock north to the relatively thinly populated Wood Buffalo Park. Between 1925 and 1928, 6,673 bison yearlings, 2-year-olds, and 3-year-olds were transported by rail and barge from Wainwright to release points along the Slave River, between the Peace River and Fort Fitzgerald. This action resulted in the swamping of the wood bison by the introduced plains animals. By 1934, Soper (1941) estimated the total Park population to be approximately 12,000, of which only one or two per cent were pure *athabascae*. Both he and Raup (1933) speculated that there might still be some small herds of pure wood bison in the northwestern portion of the park farthest removed from the points of the 1925-29 releases.

More intensive investigations of the wood bison were commenced after the Second World War. Fuller (1950) reported upon an aerial survey in 1949, outlined the range and estimated the population to be between 12,000 and 14,000. During an aerial recount of bison in the Park by the junior author in 1957, the presence of bison in the Nyarling River and Big Buffalo Lake area was discovered in the northwest corner of the park. Information from subsequent reconnaissance flights in winter and summer indicated that the herd was isolated from the Hay Camp, Lake Claire, or Grand Detour herds (Figure 1). There is an intervening area of extremely inhospitable and unproductive terrain of Karst topography, poorly defined drainage, and much muskeg, interspersed with the high sand eskers in the Ninisbith Hills, which offers little inducement to migration or movements out of the Nyarling River area. Those bison are therefore separated by distances of about 100 to 200 miles from the hybrid Hay Camp and Lake Claire herds and about 75 miles from the Grand Detour herd on the lower Slave River.

A field project was undertaken during February and March, 1959, to study this herd in more detail and to secure specimens to determine, if possible, their subspecific identity. A base camp was established on the Hay River winter road at the Nyarling River crossing. During the first few days the distribution of the herd of approximately 200 animals was outlined by aerial survey, and five specimens were secured. A yearling female was taken on February 14, an old bull on the 18th, and a young bull on the next day. A two-year-old cow was taken in the same general area on March 2, and an old cow was secured on March 12. The animals were remarkably large with exceptionally dark and woolly pelage (Plate I). The usual external measurements were taken and are listed in Table 1, where they are compared with measurements of three *athabascae* bulls recorded by Soper (op. cit.). The three adults were photographed and skinned, and the skulls sent to the National Museum of Canada, where they were cleaned and measured according to standard measurements established by Skinner and Kaisen (op. cit.) in their review of the genus in North America. Unfortunately

they dealt only with males. However, the National Museum has an adult cow *athabascae* No. 10405, taken by Chief Warden Michael Dempsey at Pine Lake, Wood Buffalo Park, in March, 1928. Skinner and Kaisen's standard measurements were taken on the 1959 cow and on No. 10405. The resulting skull measurements are listed in Table 2.

TABLE 1. EXTERNAL MEASUREMENTS OF 1959
BISON SPECIMENS COMPARED WITH EARLIER SPECIMENS

| Measurements | No. 24026 | No. 24027 | No. 24028 | Radforth Expedition° | Anderson-Hadwen° | Anderson-Hadwen° |
|---|---|---|---|---|---|---|
| Sex | bull | bull | cow | bull | bull | bull |
| Total length | 151 | 138 | 134 | 127 | 135 | 146 |
| Tail | 17 | 17 | 17 | 12 | 17.5 | 18 |
| Height at shoulder | 75 | 73 | 62 | 70 | 68 | 68 |
| Girth behind foreleg | — | — | 92 | 117 | — | — |
| Width of forefeet | — | — | 4.5 | — | 4.2 | 5.0 |
| Height of thoracic process | 17.5 | 17 | — | — | — | — |
| Estimated weight | 2,300 | 2,100 | 1,600 | 2,400 | 2,000 | 2,200 |

NOTE. Measurements in inches, weight in pounds.
°Measurements of earlier specimens from Soper (1941).

TABLE 2. SKULL MEASUREMENTS OF 1959
BISON SPECIMENS AND OF AN ADULT FEMALE TAKEN IN 1928

| Skull Measurements | Male No.24026 | Male No.24027 | Female No.24028 | Female No.10405 |
|---|---|---|---|---|
| Spread of horn cores, tip to tip | 670** | 565* | 510 | 430 |
| Greatest spread of cores | 685 | 620* | 528 | 435 |
| Core length on upper curve, tip to burr | 220 | 225 | 190 | 135 |
| Length of core on lower curve, tip to burr | 255 | 300 | 240 | 192 |
| Length, tip of core to upper base at burr | 198 | 188 | 171 | 140 |
| Transverse diameter of core | 98** | 79 | 65 | 52 |
| Vertical diameter of core | 100** | 85 | 75 | 56 |
| Circumference of core at base | 285** | 255 | 215 | 68 |
| Width of cranium between cores and orbits | 300** | 285** | 240 | 228 |
| Greatest postorbital width | 365** | 330** | 305 | 284 |
| Width of skull at masseteric processes at M1 | 204 | 194 | 184 | 172 |
| Greatest width at auditory openings | 288** | 260 | 240 | 222 |
| Width of condyles | — | — | — | 118 |
| Occipital crest to tip of nasals | 473 | 458 | 434 | 410 |
| Occipital crest to tip of nasal-frontal sutures | 270 | 254 | 229 | 222 |
| Depth, occipital crest to lower border of foramen magnum | — | — | — | 110 |
| Basilar length of skull | — | — | — | 468 |
| Overall length of skull | 603** | 580** | 535 | 505 |
| $P^2$-$M^3$ alveolar length | 142* | 153 | 148 | 142 |
| $M^1$-$M^3$ alveolar length | 86* | 94 | 91 | 87 |
| Median length of premaxilla beyond $P^2$ | 162** | 157** | 144 | 148 |
| Rostral width at maxillary-premaxillary suture | 118 | 109 | 95 | 112 |

*Indicates the measurement is under the minimum for *athabascae* listed by Skinner and Kaisen - p. 164.
**Indicates the measurement is greater than the maximum for *bison* listed by Skinner and Kaisen - p. 162. All measurements in millimetres.

Plate I

**Old bull wood bison shot March 18, 1959, on the upper Nyarling River, Wood Buffalo Park.**

Most of the measurements taken on the two bulls fall within the limits set for *athabascae* by Skinner and Kaisen (op. cit., p. 164). Thirteen measurements are greater than the maxima listed for the plains bison *(bison)* by Skinner and Kaisen (op. cit., p. 162). Four measurements fall within the limits set for bison and below the minima for *athabascae*. Those figures involve two measurements made on the tooth row of the old bull No. 24026. It should be noted, however, that experience with other large mammals has shown that tooth row measurements of aged animals usually are less than those of young adults because of excessive tooth wear. The other two measurements are associated with the hom cores of the younger bull, which were quite modest in size. The adult cow skull greatly exceeded the size of the previously taken adult *athabascae* (No. 10405).

Considering the large size of the animals, which compared favourably with earlier taken *athabascae* (Table 1), the skull measurements, and the very dark (almost black) woolly pelage, we have concluded that the speci-

mens represent an isolated population of wood bison *(Bison bison athabascae)*. The herd occupies a restricted range on the upper Nyarling River far removed from the centre of the hybrid herds on the Lake Claire Flats and Salt Plains. If there has been much contact with the southern herds, it has been a minimum contact as substantiated by the negative tuberculosis tests on the animals taken.

By coincidence the herd occupies the area from which records indicate the type specimen was taken in 1890.

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DEPARTMENT OF NORTHERN AFFAIRS
AND NATIONAL RESOURCES

OTTAWA

NUMBER 9 APRIL 13 1961

# BIRD AND MAMMAL OBSERVATIONS ON ELLEF RINGNES ISLAND IN 1960

D. B. O. SAVILE

## ABSTRACT

Collared lemmings were plentiful and arctic weasels occasional. Peary caribou and ringed seal were scarce. One white-faced musk-ox was doubtfully reported. Breeding birds, in decreasing abundance, included Snow Bunting, Brant, Long-tailed Jaeger, Rock Ptarmigan, Knot, Baird's Sandpiper, Glaucous Gull, and perhaps Hoary Redpoll. The breeding bird density near Isachsen was estimated to be *ca.* 0.15 adults per 10 acres. In sandy parts of the island the density must have been even less. It is thought that a high lemming population contributed to the breeding success of several birds through diversion of predation pressure.

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Through the courtesy of the Department of Mines and Technical Surveys I spent from June 15 to August 12, 1960, in a botanical study of Ellef Ringnes Island, particularly of the Isachsen region, while attached to the Polar Continental Shelf Project. The following notes on mammals and birds are intended to supplement the more detailed studies of MacDonald (1961). which were in press before my observations could be incorporated. It may be noted that skulls of arctic fox and musk-ox and the lower jaw of a wolf were found and turned over to the National Museum of Canada; but the Arctic Fox skull appeared to be several years old, and the others a great many, and they have no bearing on the present status of these species.

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## Mammals

**Arctic Weasel** *(Mustela erminea)*. At least two were seen by me and two others reported to me. The ones I saw were in good condition. The population may have been substantial.

**Ringed Seal** *(Phoca hispida)*. Dr. E. H. Grainger, Fisheries Research Board, secured one, and several others were seen in Deer Bay.

**Collared Lemming** *(Dicrostonyx groenlandicus)*. Abundant enough to be caught easily by hand, the population probably being near saturation for such a barren region. Young were seen in late July, and there was no sign of a crash. This animal occupies a key position in the biota of the island, providing an important food source for several predators, importantly modifying plant habitats through nitrification, and, as Mr. J.F. McAlpine found, providing in its burrows the breeding habitat for several insects. In addition, as discussed below, its population cycle seems to influence the breeding success of several birds significantly.

**Peary Caribou** *(Rangifer pearyi)*. One pair and a fawn were seen at Isachsen. Triple sets of tracks repeatedly seen in the district were thought to be of the same animals. A similar family group was seen in the Christopher Peninsula. The sparse vegetation probably does not allow the formation of appreciable herds.

**White-faced Musk-ox** *(Ovibos moschatus)*. A geologist with a petroleum survey party reported seeing. from an aircraft, a dark animal that was presumably a musk-ox. The species must lead an extremely precarious existence on the island.

## Birds

**Red-throated Loon** *(Gavia stellata)*. A group of four appeared in open water at a river mouth on July 14. Single birds were seen or heard on July 15, July 30, and August 2. Probably never breeds here. The shore leads are insignificant until early July, and the few ponds are apparently without fish. Birds nesting after early July could seldom, if ever, fledge young before freeze-up.

**Brant** *(Branta bernicla)*. All birds seen were checked carefully, and all appeared perfectly clear bellied. Two observed nests hatched 3/4 and 4/4 eggs, both about July 11-12. Another pair was seen with five young. At the end of July probably the average survival was at least three young per pair. The dearth of foxes presumably was largely responsible for the nesting success. On August 2 a gosling about 3 weeks old, separated from its family in loose pack-ice, was whistling plaintively. When I whistled back, it swam in from a quarter-mile to 75 yards from shore. At this point I noticed the two huskies from the weather station approaching, and I hurried along the shore;

but on looking back later I saw that the gosling had resumed its course. After a little hesitation it swam into the jaws of one of the dogs. Ten breeding pairs were estimated in an observation area of 15 square miles at Isachsen. A few birds were seen on the Christopher Peninsula.

Old Squaw *(Clangula hiemalis)*. A few people reported ducks briefly in the shore leads in July. No one saw them through glasses, but Dr. Grainger saw a little white on some birds and suspected this species.

Rock Ptarmigan *(Lagopus mutus)*. At least four, probably five, pairs nested in the Isachsen area. One nest hatched 7/7 eggs. Additional broods of 11, and of five (approx.) were seen. One male on August 7 still had flecks of white on its back and perhaps did not change fully into summer plumage. Females were fully changed before June 17, but males remained nearly white until early July.

Knot *(Calidris canutus)*. A few were seen several times in the second half of June, and the whistled call was occasionally heard. Then they seemed to disappear; but on July 19 Dr. Grainger saw one feigning injury about 3½ miles from camp where we first saw the species, and on July 23 two mechanics working at the airstrip saw one with four small chicks. Later I saw tracks, probably of this group, on the shore. Two breeding pairs in the area are tentatively assumed.

Baird's Sandpiper *(Erolia bairdii)*. Little suitable habitat occurs near Isachsen, and the species was very scarce. One was seen near the airstrip in an artificial depression. On July 24 one at a small marsh showed great distress at my presence and gave the *urrvik* call repeatedly. I assumed one nesting pair on this evidence. The onset of heavy rain curtailed my search for young.

Long-tailed Jaeger *(Stercorarius longicaudus)*. On the basis of reaction to my approach, I believe eight pairs nested in the Isachsen area. One nest was found with two eggs; both hatched in foul weather between July 19 and 24. On the latter date the parents' aggressive behaviour to me extended over a greatly increased range and seemed to centre some 70 to 100 yards from the nest, but I failed to find the young. From the first I refrained from raising my arms when these birds attacked. It soon became routine for one or the other to stand on my head and pull at the fur trim on my hood. With few open nests and with no berries such as to serve as emergency food further south for *Stercorarius parasiticus*, I do not see how this species could nest successfully on Ellef Ringnes in years of lemming scarcity. Several jaegers were seen on the Christopher Peninsula.

Glaucous Gull *(Larus hyperboreus)*. Three adults occurred at Isachsen, including a pair that nested on the cliff where MacDonald observed them. Michael Eaton, who found this nest, reports that a pair also nested there in 1959. Other nests reported to me were as follows: one far inland with two

eggs; one on the northeast coast with three eggs; and one on a small reef between Ellef Ringnes and Meighen islands, also with three eggs. This last nest, 21 miles from the nearest shore lead, must have presented a serious feeding problem when the eggs hatched. No data on nesting success were obtained.

Arctic Tern *(Sterna paradisaea)*. Not seen at Isachsen, but on July 29 I saw at least two at Cape Isachsen, where the shallow shore lead probably yielded small fish in some numbers. Mr. Eaton thought that there were four birds here. No evidence of breeding was obtained.

Redpoll (probably *Acanthis h. hornemanni)*. I was surprised to see a Redpoll at close range on June 23, at which time I heard another one calling. In the next two weeks one or two occasionally flew overhead. In late July they discovered the camp garbage dump and appeared there frequently but always briefly. Once I thought I saw four birds. In early August another observer thought that five were present. I accordingly suspect that one pair nested. I was unable to secure a specimen, but on the basis of the report of this race from Fosheim Peninsula and eastern Axel Heiberg Island by Parmelee and MacDonald (1961), I suspect *A.h. hornemanni*.

Snow Bunting *(Plectrophenax nivalis)*. Males were singing freely when I reached Isachsen but were nearly silent by late June. Young were heard scolding in a nest on July 12. Flying young, apparently two families, were first seen on August 2. By sampling some ridges in June when the males were still singing and by estimating the amount of suitable coarse talus in the observation area, I arrived at a rough estimate of 45 breeding pairs. A single male was seen on sandstone barrens, 10 miles from Isachsen, where plants and animals were very scarce.

## Breeding Bird Population

The proved, suspected, and estimated breeding pairs listed above total 73 for 15 square miles near Isachsen. This is equivalent to 0.15 adult per 10 acres. The figure is in sharp contrast with three tundra censuses listed by Hickey (1943) of 2.8, 6.1, and 8.5, and one by Savile (1951) of 4.8. Yet the breeding density near Isachsen was far higher than in other parts of the island where weathered sandstone or the Beaufort sand and gravel predominate. The figure emphasizes that most of this and the adjacent islands should be classed as arctic desert rather than tundra.

## Effect of Lemming Fluctuations upon Nesting Success

MacDonald's report makes it plain that nesting success was almost nil at Isachsen in 1954, a single fledgling Snow Bunting being the only young bird seen. His account of the spring and summer weather naturally suggests

that the weather contributed very strongly to the nesting failures; but actually the 1954 season was not conspicuously bad as summers go in this particularly inclement section of the arctic.

Phenological data for six plants recorded by MacDonald and myself (Table 1) suggest that, in mid-June, development in 1954 was about two days behind that of 1960, but that by late in the month, 1954 had gained until it was about three days ahead.

TABLE 1. PHENOLOGICAL DATA AT ISACHSEN

| Species | 1954 | 1960 |
|---|---|---|
| Saxifraga oppositifolia | June 20 | June 18 |
| Ranunculus sabinei | " 25 | " 25 |
| Draba oblongata | " 26 | " 24 |
| Draba subcapitata | " 26 | " 24 |
| Cerastium arcticum | " 26 | " 29 |
| Potentilla hyparctica | " 26 | " 29 |

A comparison of the weather records, provided by the Meteorological Branch, Department of Transport, is summarized in Table 2.

The two seasons agree quite closely, especially between mid-June and mid-August, which covers the incubation and fledging time of most species. The severe cold of June 1954 was limited to the first four days. August 1960 was relatively dry and warm, but only because of fine weather in the third week. The first two weeks were as cold and wet as in 1954. Although both summers were wet, they were substantially drier than 1953 in which the three-month precipitation total was 3.88 inches. The only extreme recorded in either year was the July 1960 minimum of 26 degrees, which equals the record set in 1956.

TABLE 2. SUMMER WEATHER AT ISACHSEN

| | 1954 | | | 1960 | | | 13-yr. Av. | | |
|---|---|---|---|---|---|---|---|---|---|
| | June | July | Aug. | June | July | Aug. | June | July | Aug. |
| Rain (in.) | Tr. | 1.34 | 1.49 | 0.01 | 0.66 | 0.54 | 0.01 | 0.65 | 0.65 |
| Snow | 1.0 | 0.0 | Tr. | 1.2 | 5.1 | Tr. | 1.3 | 1.9 | 1.6 |
| Total Pptn. | 0.1 | 1.34 | 1.49 | 0.13 | 1.17 | 0.54 | 0.14 | 0.84 | 0.81 |
| Max. Temp. °F. | 54 | 53 | 53 | 55 | 52 | 55 | 47 | 56 | 48 |
| Min. Temp. | 11 | 29 | 28 | 19 | 26 | 23 | 13 | 28 | 21 |
| Mean Temp. | 32.0 | 38.0 | 36.8 | 33.4 | 38.2 | 37.4 | 31.3 | 38.4 | 34.3 |

Much, if not all, of the contrast between the two seasons seems to be due to the lemming population. A supply of lemmings is clearly essential to the breeding success of the Long-tailed Jaeger in this region with little alternative food. Indirectly the lemmings seem to affect most other species of birds by controlling or diverting predators. In 1954 the starving weasels seem to have raided almost every nest of the Snow Bunting; and they and the foxes seem to have accounted between them for all nests on open ground. The next lemming crash, probably in 1957, seems to have virtually eliminated foxes from the island, and none were seen in 1960. Weasels were present, but, with lemmings so abundant, they probably robbed few nests.

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Natural History Papers

National Museum of Canada

DEPARTMENT OF NORTHERN AFFAIRS
AND NATIONAL RESOURCES

OTTAWA

NUMBER 10 APRIL 13 1961

# NOTEWORTHY RECORDS OF MARINE MOLLUSCS FROM THE BAY OF FUNDY

By E. L. Bousfield

While visiting the coarse sand beach inside Partridge Island, south of Parrsboro, Nova Scotia, on July 22, 1958, the writer found three fragmentary valves of a heavy ark shell and eight partial valves of a strongly ribbed venerid clam. The specimens obviously did not fit the descriptions of known Canadian Atlantic bivalve species and were set aside for further study. These records (material determined to family) were later published in a general faunistic survey of the Minas Basin region (Bousfield and Leim, 1960).

A further search of the eastern end of this beach on August 22, 1960, resulted in the discovery of three fragments (one a complete valve) of the ark shell and two nearly entire valves of the venerid clam. The best fragments were only slightly water-worn and readily determined as *Noetia ponderosa* Say 1922 and *Chione cancellata* L. 1767. A single, large, deeply cupped valve of *Mulinia*, most closely referable to *M. lateralis corbuloides* Deshayes 1854, was also taken at this locality.

The presence of these three species on this beach is especially noteworthy. As a recent shell, *Noetia ponderosa* is known from Virginia to Key West, Louisiana, and the Gulf of Mexico; *Chione cancellata* from North Carolina to Florida, Texas, and the West Indies; and *M. lateralis corbuloides* from Beaufort, North Carolina, to Texas (Johnson, 1934; Smith, 1937; Abbott, 1954). They are not listed in LaRocque (1953), nor Bousfield (1960), nor as fossils north of New England* and are presumably new to Canada.

* Subfossil specimens of Noetia ponderosa are rarely washed ashore on the beaches, of Nantucket, Mass. (Abbott, 1954).

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*Noetia ponderosa, Chione cancellata,* and *M. l. corbuloides* normally range in the subtropical or Carolinian coastal marine zone, as delimited by Johnson (1934), a zone which, according to data of Parr (1933) and Fuglister (1947), is characterized by average minimum winter temperatures of about 10° to 12°C. and minimum summer temperatures of about 25°C. At the mouth of Minas Basin, where the present material was obtained, maximum winter temperatures are about 3°C. and maximum summer temperatures about 15°C. These temperatures are presumably well below the minimum reproductive and year-round survival levels of *Noetia, Chione,* and *Mulinia,* and indicate strongly that these animals will not be found living in this region today. Cognizant of these temperature limitations and of subfossil occurrence of at least one of these species in the Cape Cod region, the probability is high that the present material is subfossil, that the deposits are located subtidally in Minas Channel, and that strong tidal currents are eroding the beds and concentrating the loose shells on Partridge Island beach. The possibility that the shells were part of discharged ballast from 19th century trading ships cannot be completely discounted, although the restricted species composition of the material and the year-to-year occurrence on the beach so long after sailing vessels disappeared from these waters, does not favour such an hypothesis.

On the assumption, therefore, that the present molluscan material is subfossil, we may deduce probable conditions of water temperature and faunistic assemblages that formerly prevailed in that area. The presence of "Virginian" littoral marine molluscan and crustacean faunas in eastern Canada, separated from their present centres of distribution (Cape Cod to Cape Hatteras) by a large area of cold water (Gulf of Maine), has previously been attributed to one or more post-Pleistocene warm periods (e. g. Bousfield, 1956, 1958). Higher water temperatures would have been a logical result of lowered sea-levels and reduced tidal mixing, particularly in the northern part of the Gulf of Maine, immediately following the last ice advance. Conditions were evidently sufficiently warm not only to have permitted the continuous dispersal of Virginian faunas throughout the northern Gulf region, from which they are now all but excluded, but also to have invited the northward penetration of Carolinian elements into the Canadian Atlantic region. Baker (1951) gives northern records of *Noetia ponderosa, Chione cancellata,* and *Mulinia lateralis corbuloides* from the Delmarva peninsula of the eastern United States and lists 56 other molluscan forms, of which 25 are still found in eastern Canada. We may surmise, therefore, that temperature conditions in the Bay of Fundy may have formerly been analogous to those of present-day southern Chesapeake Bay and that the molluscan fauna included Virginian and Carolinian elements such as *Pecten irradians, Polinices duplicata, Donax fossor,* and *Busycon canaliculata,* which may yet be discovered as fossils in the region.

I wish to thank Dr. Arthur H. Clarke, Jr., for his assistance in determining the present material and for helpful comments on the manuscript.

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*Natural History Papers*

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DEPARTMENT OF NORTHERN AFFAIRS
AND NATIONAL RESOURCES

OTTAWA

NUMBER 11 JULY 24 1961

# PLACEMENT OF THE PROWFISHES, ZAPRORIDAE, IN THE SUPERFAMILY STICHAEOIDAE

D. E. McAllister and R. J. Krejsa[1]

## HISTORY

The systematic placement of the prowfish, *Zaprora silenus* Jordan 1896, has been an enigma. After relating it to various other groups, Jordan, Evermann, and Clark (1930) placed the monotypic Zaproridae in the Order Jugulares following the Bathymasteridae. Chapman and Townsend (1938) after an osteological study were unable to determine the prowfishes' relationships, although they were able to negate several previous proposals. Berg (1940) provisionally placed the prowfish in the suborder Blennioidei as an *incertae sedis* family. Norman (MS) placed them as an *incertae sedis* family in the Perciformes. Bertin and Arambourg (1958) did not mention the family in their classification. Matsubara (1955) provisionally placed them in the Zoarcicae. Neither Clark Hubbs (1952) nor Makushok (1958) have mentioned the family in their recent revisions of portions of the blennioid fishes. Romer (1955) placed Zaproridae in the suborder Trachinoidea. It may be seen that there has been little certainty in the taxonomic relegation of the prowfishes, even though their osteology is known.

The striking similarity between the larvae of *Zaprora* (see Figs. 9 and 10, Champman and Townsend) and the larvae of the wolffishes, Anarhichadidae (see Bigelow and Schroeder, 1953, Fig. 267, or Barsukov, 1959, Fig. 42) leads the authors to consider the possibility of their relationship. The arrangement of the fins, the enlarged pectoral fin and eye, and other features of these larvae are very similar. Comparison of skulls of the two groups showed considerable differences, although the differences could

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be attributed to a strengthening of the lower jaw and skull in response to hard molluscan food in Anarhichadidae.

Comparison was then made with superfamily Stichaeoidae, recently erected by Makushok (1958) to include Stichaeidae, Pholidae, Ptilichthyidae, and Anarichadidae. The following characters of Zaproridae are in agreement with Stichaeoidae: Body elongate with cycloid scales extending onto head; a single unpaired nostril opening on each side of the head; gill arches 4, with a slit behind the last; pseudobranch present; upper pharyngeal teeth in 2 patches; swim bladder absent; pararticular bone present; in the cephalic sensory canals the supraorbital commisure is not connected to the occipital canal (the latter is not interrupted in the middle); the suborbital bones number 7 or 8; the postorbital canal ends on the supracleithrum; there is a dorsal and a median line of exposed pit organs along the body; the total number of vertebrae including the urostyle varies from 61 to 62 with 24 to 26 abdominal; the vertebral centra are symmetrical; the first vertebra with a parapophysis is the 6th; the first rib is on the 4th vertebra; epipleural ribs are present; the dorsal and anal fins are long, undivided, and reaching almost to the caudal; one interneural and one interhaemal per vertebra; anteriormost interneural inserted between the neural spines of the first and second vertebrae; the dorsal contains only spines; the anal fin begins immediately behind the anus; *the first three rays of the anal are spines;* the preanal distance is about half the total length; caudal fin round; caudal skeleton with 3 epurals, 2 epaxial hypurals (fused basally), one broad hypaxial hypural perforated for the caudal vein and without a hook-like projection; total caudal rays 16 + 17 = 33 (31–34); a scapular foramen; scapula and coracoid well developed; pelvic fins and girdle absent; soft rays of pectoral, caudal, and anal branched 2 or 3 or more times; the cranial cavity not prolonged into the orbital region (unlike Cryptacanthodidae); a median cartilaginous membrane connecting the anterior frontals and parasphenoid; basisphenoid absent; supraoccipital with small crest; skull lateroparietal; a somewhat reduced opercular siphon.

Other pertinent characters also found in Zaproridae are the 6 branchiostegals, with 2½ epihyal + 3½ ceratohyal and 4 external + 2 ventral (indicating the prowfish to be a perciform); 4 mandibular and 7 preopercular pores; 8 suborbital pores; no vomerine or palatine teeth; no tooth-like lateral projection on the first vertebra; gill membranes broadly joined and free from isthmus; postcleithra absent; a keel on upper and lower sides of the parasphenoid. Contrary to Chapman and Townsend (1938), a supramaxillary was not found although a strengthening mesial ridge gives the maxillary the appearance of bearing a supramaxillary.

The following characters do not agree with Makushok's description of Stichaeoidae: pleural ribs begin on the 4th, not the 3rd vertebra: princi-

pal caudal rays are 16, (7 dorsal + 9 ventral), not 12–15; pectoral rays vary from 24–25, rather than 8–21; the descending wings of the frontal do not quite touch the ascending wings of the parasphenoid, being separated by the alisphenoid. (Since the alisphenoid is seen to separate the frontal and parasphenoid in Fig. 43 of *Lumpenella*, Makushok, this difference is not accorded great significance.) Other characters not mentioned in the superfamily description but in which Zaproridae differs from the Stichaeoidae are the 7 preopercular pores, rather than 6 or less, and the pyloric caecae about 36, instead of 0 to 7.

None of the above differences are considered highly significant. They are merely slight extensions in the ranges of variability. With a slight enlargement of characteristics the superfamily Stichaeoidae would readily accommodate the family Zaproridae. That Zaproridae should be included in Stichaeoidae is indicated by the agreement of numerous important characters outlined above.

Of the Stichaeoidae, Zaproridae seems to be most closely related to the Stichaeidae, and of the Stichaeidae perhaps closest to the Opisthocentrinae. Phylogenetically, Zaproridae should probably take its place between the Stichaeidae and the Anarhichadidae.

It is interesting to note that the jelly fish eating habit of the prowfish has a counterpart in some species of *Chirolophis* (Chirolophinae, Stichaeidae) which nip sea anemones from the substrate.

In conclusion, the monotypic North Pacific family Zaproridae should be placed in the expanded superfamily Stichaeoidae, suborder Blennioidei, Order Perciformes (Percomorphi). This placement is confirmed by cranial, axial, and caudal skeletal characters, by internal and external soft anatomy.

## MATERIALS

*John N. Cobb* cruise 33, 17 young specimens, one of which was cleared and stained with alizarin, from Alaska: 56° 49' N, 136° 52' W; W58-1, 1 skull of young specimen from Alaska: Thomas Bay, Frederick Sound (the latter two collections of N. J. Wilimovsky are now in the Institute of Fisheries collection); BC60-172, of the Institute of Fisheries, University of British Columbia, 1 large adult from B. C. : 20 miles northwest of Cox Island.

## Acknowledgments

The authors are deeply grateful to Dr. N. J. Wilimovsky for permission to use his specimens and for literature. We are also indebted to Dr. C. C. Lindsey for Institute material. Mr. Tatsuji Ueno kindly translated a portion of Matsubara (1955).

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1961


# Natural History Papers

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OTTAWA

NUMBER 12 JULY 3 1961


## NEW RECORDS OF FRESH-WATER AMPHIPOD CRUSTACEANS FROM OREGON

E. L. Bousfield

The present account is based on samples of fresh-water amphipods collected during 1955–61 in the vicinity of Portland by Dr. Eugene H. Kozloff and biology students of Lewis & Clark College, Portland, Oregon. Five species have been identified, of which *Anisogammarus similimanus* is new to science, *Crangonyx pseudogracilis* Bousfield is recorded for the first time from the Pacific watershed, *Crangonyx richmondensis occidentalis* H. & H. and *Hyalella azteca* Saussure are herewith confirmed for Oregon, and *Anisogammarus oregonensis* is now known from the northern part of the state.

Compared with other regions of the North American Pacific watershed, Oregon has a relatively rich fauna of fresh-water amphipods. Of fifteen species now known to occur in tidal and non-tidal fresh waters from Alaska to California, ten species, as listed in the following key, are known from the state of Oregon (see Barnard, 1954; Bousfield, 1958). Of Behring Arc species of seaside streams and pools (e.g. *Anisogammarus locustoides* Brandt, *Paramoera carlottensis* Bousfield, and *P. columbiana* Bousfield), only the latter might be expected to reach Oregon. The tundra pool *Synurella johanseni* Shoemaker is known only from west-central Alaska*, and the glacial relict *Pontoporeia affinis* Lindstrom has been taken southward only to Lake Washington. The fact that three of the fifteen American Pacific species are endemic to Oregon may be attributed to the more varied and geologically more permanent system of fresh-water habitats in this region. Unlike the dry central and southern parts of California where amphipod species are few, much of the coastal and southern sections of Oregon receives abundant rainfall and thus contains an extensive network of spring-

*Pearse (1913) recorded "*Crangonyx vitreus* (Cope)" from a creek 80 miles north of Rampart House, Alaska, but the identity of this material is questionable (Shoemaker, 1942a).

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fed streams and rivers in which these animals can live permanently. The relatively mild winters in this region, coupled with cool summers, make for year-round uniformity of water temperature at levels which are well within the thermal limits of reproduction in both cold-water breeders (e.g. *Crangonyx r. occidentalis, Gammarus lacustris)* and warm-water forms (e.g. *Hyalella azteca, Crangonyx pseudogracilis).* As Oregon was not exposed to Pleistocene glaciation, very old surface drainage patterns and subterranean water systems persisted to the present day with a corresponding survival of ecologically restricted species of amphipods. Although *Stygobromus hubbsi* Shoemaker 1942 is, to date, the only cave stream species of amphipod known from the American Pacific slope, more thorough collecting, especially in Harney County and southeastern parts of Oregon, will undoubtedly yield other subterranean forms.

I am greatly indebted to Dr. Kozloff and his associates for making this collection available, and to Mrs. J.G. Stamper for her assistance in preparation of the drawings.

## Simplified Key To Oregon Species of Fresh-Water Amphipods

1. Coxal plates 1–4 very shallow, 4th not excavate behind; antenna 2 distinctly thicker and more powerful than antenna 1; animal living in tube; tidal fresh waters, mouths of seaside streams, reservoirs .... *Corophium spinicorne* Stimpson.

Coxal plates 1–4 deeper than wide, 4th excavate behind; antenna 1 not noticeably more powerful than antenna 2; animal non-domicolous .....2.

2. Pleosome segments 1 and 2 with backward-projecting mid-dorsal tooth; antenna 1 without accessory flagellum; in lakes, ponds, streams ..... *Hyalella azteca* Saussure.

Pleosome segments not dorsally carinate, may have small spines and/or setae; antenna 1 with accessory flagellum of two or more segments .....3.

3. Urosome segments with dorsal clusters of spines and setae; accessory flagellum of 2–7 distinct segments; male larger than female. . . *Gammarus* section 4.
Urosome segments dorsally smooth; accessory flagellum of one distinct segment and a minute terminal joint; female usually larger than male. . . *Crangonyx* section 8.

4. Uropod 3, inner ramus shorter than peduncle; gnathopod 1 usually larger than gnathopod 2; coxal gills with cylindrical appendages.....*Anisogammarus* 5.
Uropod 3, inner ramus longer than peduncle; gnathopod 1 not larger than gnathopod 2; coxal gills simple; in alpine lakes and ponds..... *Gammarus lacustris lacustris* Sars.

5. Abdominal (pleon) segments 1–3 with clusters of spines mid-dorsally near posterior border; inland fresh-water streams.... *Anisogammarus oregonensis* Shoemaker.

Abdominal segments 1–3 dorsally with a few short spines.....6.

6. Eyes large, nearly touching front margin of head; antenna 2 of male, flagellar segments bearing calceoli; tidal fresh waters and brackish pools. *A. confervicolus* Stimpson.

Eyes medium small, not touching anterior margin of head; antenna 2 of male without calceoli; fresh-water streams only, rarely in brackish pools.....7.

7. Urosome segments appearing slightly "humped" in lateral view, bearing longish spines and setae; gnathopods 1 and 2 about equal in size and shape; inland streams..... *Anisogammarus similimanus* n. sp.
Urosome segments regular in outline, with short dorsal spines and setae; gnathopod 1 distinctly longer than gnathopod 2; seaside streams..... *A. ramellus* Weckel.

8. Eyes absent; uropod 3 uniramous, ramus shorter than peduncle; cave streams ..... *Stygobromus hubbsi* Shoemaker.
Eyes present; uropod 3 biramous, outer ramus longer than peduncle; surface waters ..... *Crangonyx* 9.

9. Uropod 2 of male, outer ramus with a few spines of normal type; gnathopods 1 and 2 of female, palmar margin lined with numerous, heavy, notched spine teeth; animals large (11–15 mm.)..... *Crangonyx richmondensis occidentalis* H. & H.
Uropod 2 of male, outer ramus distally with numerous fine comb spines; gnathopods 1 and 2 of female, palmar margin lined with a few weak spine teeth; animals small (5–9 mm.)..... *Crangonyx pseudogracilis* Bousfield.

## MATERIAL EXAMINED

### Family GAMMARIDAE

1. **Anisogammarus similimanus** n. sp.

Crystal Springs, Eastmoreland District, S. E. Portland, Multnomah Co., from fast-moving spring stream, under rocks: James Bond coll., Feb. 25, 1958, male type, female allotype, NMC No. 2304; 9 paratype males and 14 paratype females, NMC No. 2305.

*Diagnosis* (fig. 1). Similar to *A. ramellus* Weckel in general characteristics but differing principally in heavier setation of the antennae, in dorsal humping and more prominent armature of the urosome, in more rounded lateral angle of the head, and in subequal size of gnathopods 1 and 2 in the male.

*Male* (10–11 mm.). Interantennal lobe with rounded anterior angles, upper angle broadly rounded. Eye rather small, broad-reniform, black. Antenna 1, peduncular segments 1–3 with 1, 3, and 1 ventral groups of setae (exclusive of terminal groups), each group composed of 3–5 medium-long setae; flagellum of about 25 segments; accessory flagellum very short, of 3–4 segments, barely exceeding the first two flagellar segments. Antenna 2, peduncular segments 4 and 5 slender, with 3–4 clusters of long setae on lower margin; flagellum of 10–12 segments, without calceoli.

Lower lip, outer lobes short, inner lobes weak, inner margins lined with short slender spines and fine setae. Mandibular palp, outer margin of segment 3 with one group of 4–5 setae; inner margin of segment 2 having distal row of about 8 long setae and proximal group of 10 short setae.

Maxilla 1, inner plate with 16–17 plumose marginal setae, outer plate with 11 spine teeth, mostly pectinate. Maxilla 2, inner plate with oblique facial row of 17 longish setae. Maxilliped, inner plate with 5 apical spine teeth and 3–4 plumose setae along inner margin; palp, outer margin of segment 3 with one group of setae.

Coxal plate 1 with broadly rounded corners, lower margin with short spines only. Gnathopod 1, segment 5 subtriangular, posterior margin with 2 groups of setae; segment 6 thick, powerful, almost subovate, palmar margin oblique and deeply indented below hinge of powerful, smoothly curving dactyl; posterior angle rounded and margin lined with about 10 heavy peg-like spines; inner face of segment 6 with 2–3 groups of superior lateral setae.

Gnathopod 2, coxal plate broadly rounded below, margin with 10 small spines; segment 5 with 2–3 groups of posterior setae; segment 6 subrectangular, almost equal in size and shape to that of gnathopod 1, posterior margin with 7 groups of setae, palmar margin deeply indented near the middle and armed, below this notch to the smoothly rounded posterior angle, with stout peg-like spines; inner face with two groups of superior lateral and four groups of inferior lateral setae.

Peraeopods 1 and 2 rather heavily setose posteriorly. Peraeopods 3–5, segments 4–6 with clusters of long spines and setae on anterior and posterior margins; spines nodulose near middle. Peraeopod 3, posterior margin of segment 2 (basos) concave, lined with 10–11 short spines. Peraeopod 5, anterior margin of segment 2 nearly straight, with few spines, posterior margin convex, lined with about 12 longish setae. Coxal gills present on peraeon segments 2–7, each with paired cylindrical appendages.

Pleopods normal, rami subequal, 15–18 segmented, nearly twice the peduncle; peduncle of pleopod with two stout coupling spines and two short stiff setae distally on inner margin and 6 longer setae distally on outer margin.

Abdominal side plates 2 and 3, posterior margins nearly straight, lined with several long setae, hind corners nearly quadrate. Posterior margins of pleon segments with mid-dorsal setae. Urosome segments appearing somewhat humped in lateral aspect, with paired clumps of long spines and setae, 1–2 spines per clump, set prominently on either side of the mid-dorsal line. Uropod 3, outer ramus broad, about three times the peduncle, terminal segment short; inner ramus very small, inner margin distally with spines and setae.

Telson cleft about ¾ to the base, lobes each with long apical spine and setae.

*Female* (7–8 mm.). Gnathopods 1 and 2 very much smaller than in male, subequal, segment 6 of gnathopod 2 more slender than in gnathopod 1, palmar margin nearly perpendicular and only slightly indented. Brood plates rather

short and narrow, decreasing successively in size from segment 2 to segment 5. Uropod 3 with relatively short, stout, weakly armed outer ramus.

*Remarks.* This species also differs from *A. ramellus* which has been taken so far only in coastal streams and lakes throughout its range. Like *A. oregonensis*, which it resembles in structure of gnathopods, *A. similimanus* occurs well inland from the coast, in streams which flow into large inland rivers.

2. **Anigogammarus oregonensis** Shoemaker 1944

A single ovigerous female was noted in the lot of *A. similimanus* (above) from Crystal Springs, Eastmoreland District, Multnomah Co., collected by J. Bond, Feb. 25, 1958. The species has previously been recorded only from Lincoln County and Lane County, both in the west-central part of Oregon, and all were from inland creeks and lakes.

3. **Crangonyx richmondensis occidentalis** Hubricht & Harrison 1941

Four males and four ovigerous females of typical form were taken under rocks and limbs along the shores of a small pond on property of Oswego Lake Country Club., Clackamas Co., Mar. 2/58, J. Bond coll., in company with the following species, *C. r. occidentalis* had previously been recorded from Washington and British Columbia (Bousfield 1958), and its range is now extended south to Oregon.

4. **Crangonyx pseudogracilis** Bousfield 1958

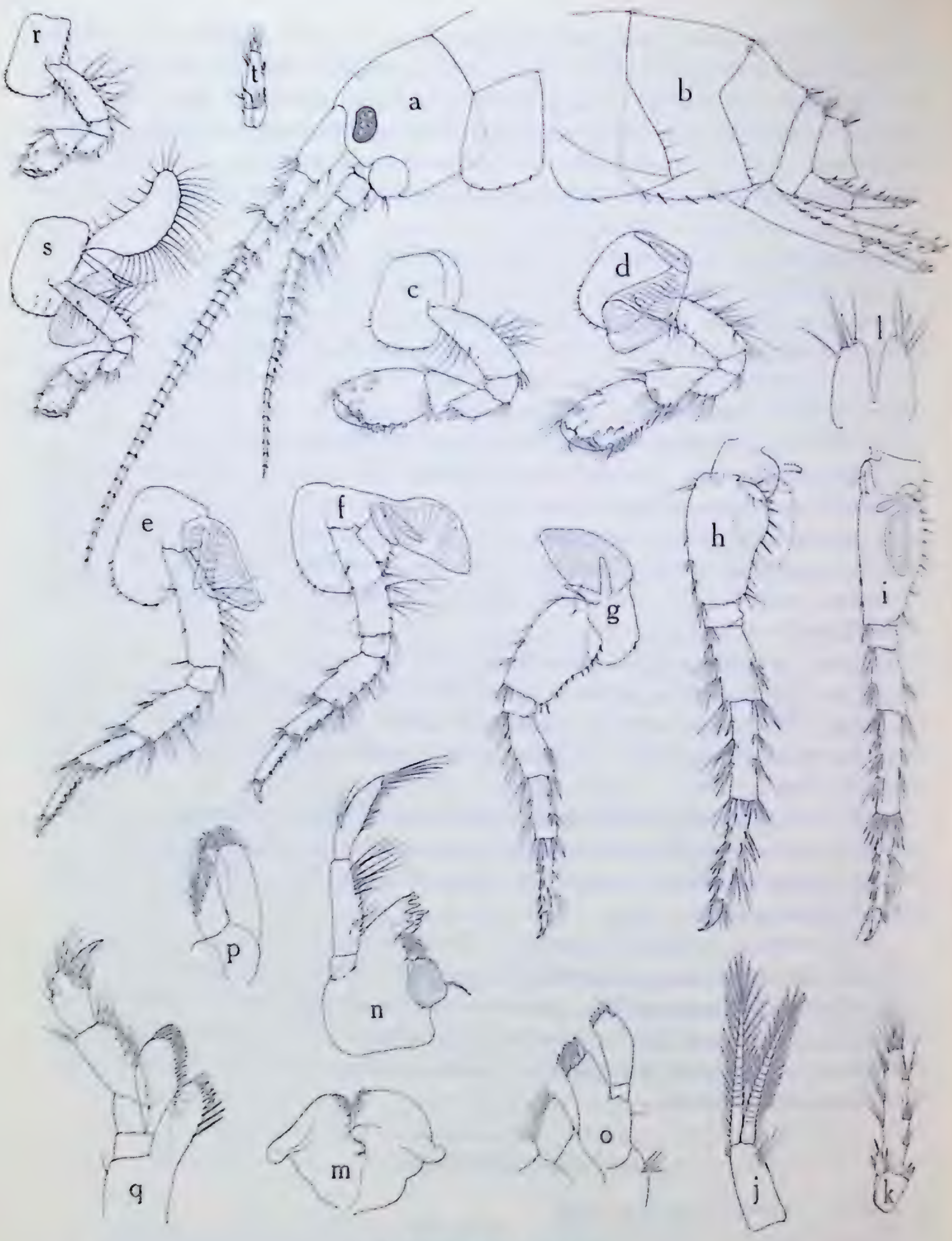
This species occurred in three of the five lots examined, as follows: (1). Boggy Inlet of Lake Oswego, 1½ miles west of town, Clackamas Co., in moss on submerged log, Feb. 18/58, James Bond coll. – 3 ovigerous females, 1 juv.
(2). Small pond on property of Oswego Lake Country Club, Clackamas Co., under rocks and limbs along shore, Mar. 2/58, J. Bond coll. – 5 males, 3 females (ov.).
(3). Small pond as above, Jan. 8/61, Judy Williams coll. – 6 males, 2 imm. males, 2 imm. females.

The material is fairly typical of the eastern populations except that, in the female, the posterior angles of segment 6 of the gnathopods have one or two fewer small spines. The male has, typically, fine comb spines on the outer ramus of uropod 2. The species had hitherto been unreported west of the Missouri R. system and marks its first appearance on the Pacific side of the Continental Divide.

## Family TALITRIDAE

5. **Hyalella azteca** Saussure 1858

Three females and 7 immatures (at least one a male) were collected in a small pond on property of Oswego Lake Country Club, Clackamas Co., Jan. 8/61 by Judy Williams. Although expected to occur in Oregon on the basis of its broad range in N. America, this appears to be the first published record of its occurrence in the state.




## Legend for Figures

*Anisogammarus similimanus* n. sp. Male holotype: (a) head and antennae, (b) abdominal segments 2–6 and uropods 1–2, (c) gnathopod 1, (d) gnathopod 2, (e) peraeopod 1, (f) peraeopod 2, (g) peraeopod 3, (h) peraeopod 4, (i) peraeopod 5, (j) pleopod 1, (k) uropod 3, (l) telson, (m) lower lip, (n) mandible, (o) maxilla 1, (p) maxilla 2, (q) maxilliped. Female allotype: (r) gnathopod 1, (s) gnathopod 2, (t) uropod 3.

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OTTAWA, 1961

Cat. No. R95–5/12 Cat. No. R 95–5/12

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# Natural History Papers

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DEPARTMENT OF NORTHERN AFFAIRS
AND NATIONAL RESOURCES

OTTAWA

NUMBER 13 NOVEMBER 10 1961


# TOXOTHERIUM HUNTERI, A PECULIAR NEW OLIGOCENE MAMMAL FROM SASKATCHEWAN

HORACE E. WOOD, 2ND

A lower jaw fragment carrying three teeth adds an altogether new component to the well known Oligocene land mammal fauna of North America. This specimen was originally included among a National Museum of Canada collection of Cypress Hills rhinocerotoids assigned to me for study. Its unique characters set it so far apart from the rest of the material that it is preferable to describe it alone. This also may have the advantage of stimulating search for additional specimens of this enigmatic form in existing collections or in the field.

I am indebted to Dr. Loris S. Russell for the opportunity to describe this intriguing new form, to Dr. Florence D. Wood for the drawings, and to Dr. Ramsay Spillman, for the X-rays.

Order **PERISSODACTYLA**
Suborder CERATOMORPHA
Family INCERTAE SEDIS

**Toxotherium hunteri**, n. gen. and sp.[1]

*Type.* – N.M.C. No. 8918, anterior half of the right ramus of the lower jaw, with three cheek teeth, interpreted as $P_{\overline{2\text{-}4}}$.

*Horizon and locality.* – From the Cypress Hills Formation, early Oligocene, Cypress Hills, Saskatchewan, Canada, collected in 1936 by Mr. Fenley Hunter.

[1] The names are intended to be distinctive without being misleading, whatever future discoveries may reveal as to the complete animal. The generic name is from Τόξοσ, bow; Θηρίον, beast or mammal, from the bowed talonid crests of the three teeth. The specific name recognizes the collector, Mr. Fenley Hunter, who has made many contributions to the science of vertebrate palaeontology.

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*Diagnosis.* – Single, disproportionately large, bulbous-rooted lower front tooth (incisor or canine); premolar paraconid regions, especially of $P\frac{}{3}$ unusually distinct; $P\frac{}{2\text{-}4}$ carry asymmetric trigonid and talonid crescents; premolar metaconids, especially of $P\frac{}{4}$, relatively isolated cusps for stage of premolar metamorphosis; teeth incipiently high crowned.

## DESCRIPTION

This portion of the right ramus begins with the symphysis and bears three cheek teeth. There is a curious bulbous alveolus for a massive front tooth, in front of, and ventral to, the diastema. This cavity seems too bulbous for an enlarged incisor of rhinocerotoid type; its size in relation to the premolars is more like an amynodont canine but is much more procumbent in position. There is no indication on either the surface or X-rays that this cavity is due to an abscess or other diseased condition. Tentatively, it is interpreted as either an unusually large semi-procumbent canine of unusual shape or an enlarged lower incisor, possibly somewhat like that of *Thylacoleo*. The diastema is short, followed by a double alveolus, presumably for $P\frac{}{1}$, with the posterior root noticeably larger than the anterior one. The three teeth are interpreted as $P\frac{}{2\text{-}4}$. As all are somewhat worn, with the middle of the three considerably more worn than the last, it would seem to rule out interpreting the last tooth as $M\frac{}{1}$. Since X-ray photographs show fully developed roots and no trace of successional teeth, these are surely permanent teeth. The first impression is of an Eocene perissodactyl because of its small size, but the teeth seem a little too high crowned (Fig. 1, 3) and the premolar metamorphosis has gone rather far in terms of a rhinocerotoid pattern. The trigonid and talonid crescents are asymmetrical, in what seems, at first glance, rhinocerotoid fashion but there are some contradictory details (Fig. 2). The most striking of these is the relative distinctness of the metaconid which is demarked from the protoconid by an anterior valley, a separation which becomes more striking from $P\frac{}{2}$ to $P\frac{}{4}$, reversing the expectable situation. There are no external or internal cingula, and the anterior and posterior cingula are very delicate, the posterior cingulum of $P\frac{}{4}$ being so delicate as to suggest rather the shadow of a lost cingulum. In $P\frac{}{2}$, the trigonid crescent is small but essentially complete; the talonid crescent has a higher, curved hypoconid region, which is functionally continued by the entoconid region, which, however, descends lingually and joins the postero-internal cingulum. Further wear would make the talonid seem fully molariform. In $P\frac{}{3}$, the paraconid region forms a somewhat distinct cuspule; both crescents are complete, at least as shown at this stage of wear. $P\frac{}{4}$ is noticeably larger, especially in width, than $P\frac{}{3}$; both crescents are molariform, and the posterior cingulum is only barely indicated. The anterior end of the alveolus of $M\frac{}{1}$ indicates that it, in turn, was a substantially wider tooth than $P\frac{}{4}$.

## MEASUREMENTS

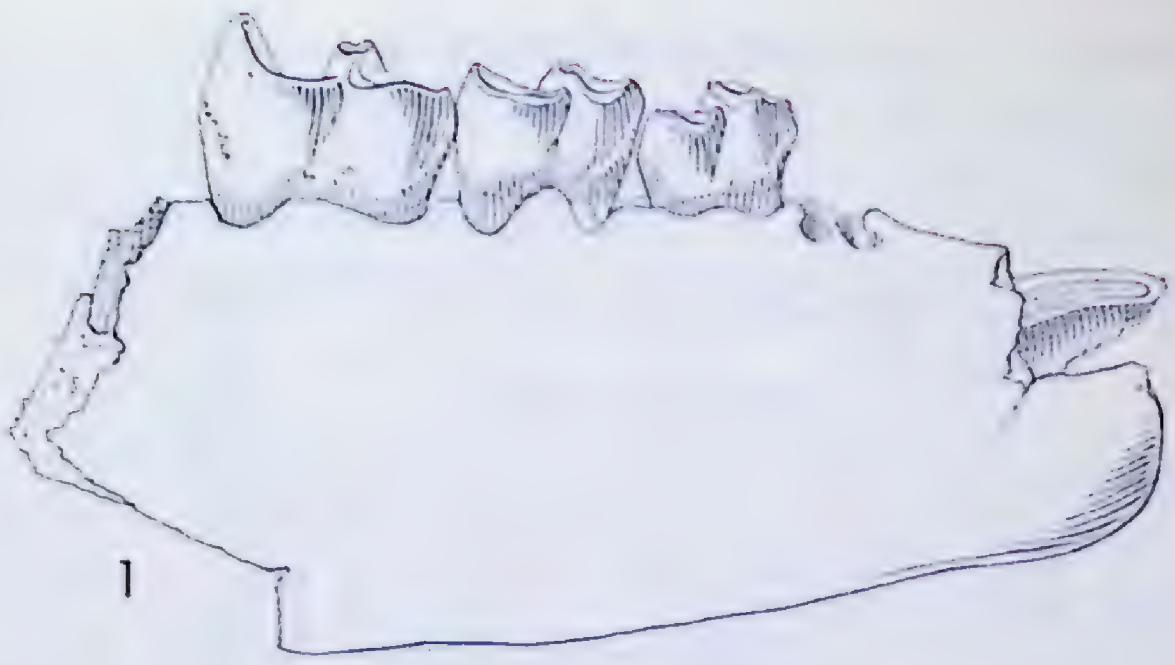
Right

| | |
|---|---|
| Depth below $P\frac{}{2}$ | 24.6 |
| Diastema | e 8.7 |
| $P\frac{}{1\text{-}4}$ | 37.5 |
| $P\frac{}{2\text{-}4}$ | 32.6 |
| $P\frac{1}{}$ (roots) AP. 4.9 | |
| $P\frac{}{2}$ AP 8.3 Tr. | 5.6 |
| $P\frac{}{3}$ AP 10.3 Tr. | 6.1 |
| $P\frac{}{4}$ AP 14.1 Tr. | 8.0 |

## DISCUSSION

This is clearly a distinctive new genus and species of placental mammal, with a puzzling combination of characters. It appears to belong to the order Perissodactyla and the Suborder Ceratomorpha. It is probably assignable to the Superfamily Rhinocerotoidea, or conceivably, in or near the Lophialetinae, wherever they may belong, since it shows some resemblances to *Schlosseria* and *Lophialetes* of the Irdin Manha of Mongolia. On present knowledge, it is easier to exclude this genus from any known perissodactyl family than it would be to include it in any family as now known. Although this is an incomplete specimen, it should be put formally on record to call attention to a new and distinctively adapted member of the North American Oligocene mammalian fauna. Possibly this was a northern form, with the southern limit of its range near the Cypress Hills of southern Saskatchewan.

[2] Measurements are in millimetres; abbreviations: AP, antero-posterior; Tr, transverse; e, estimated.



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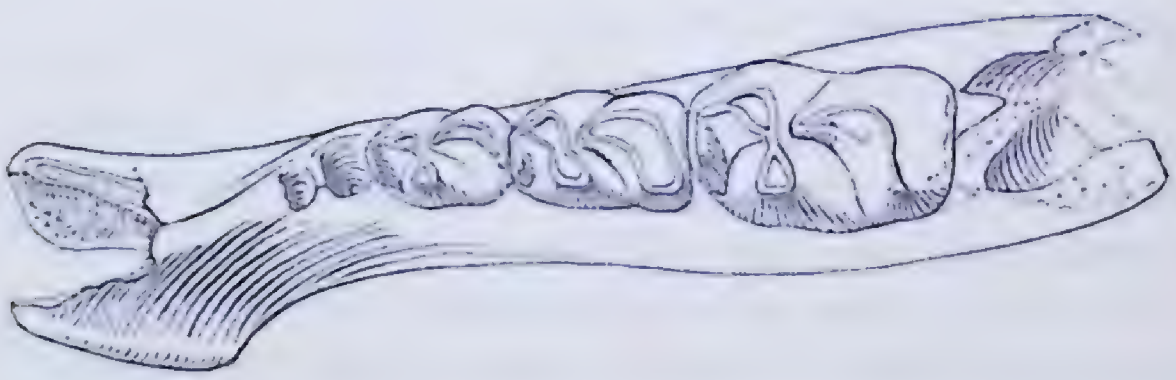

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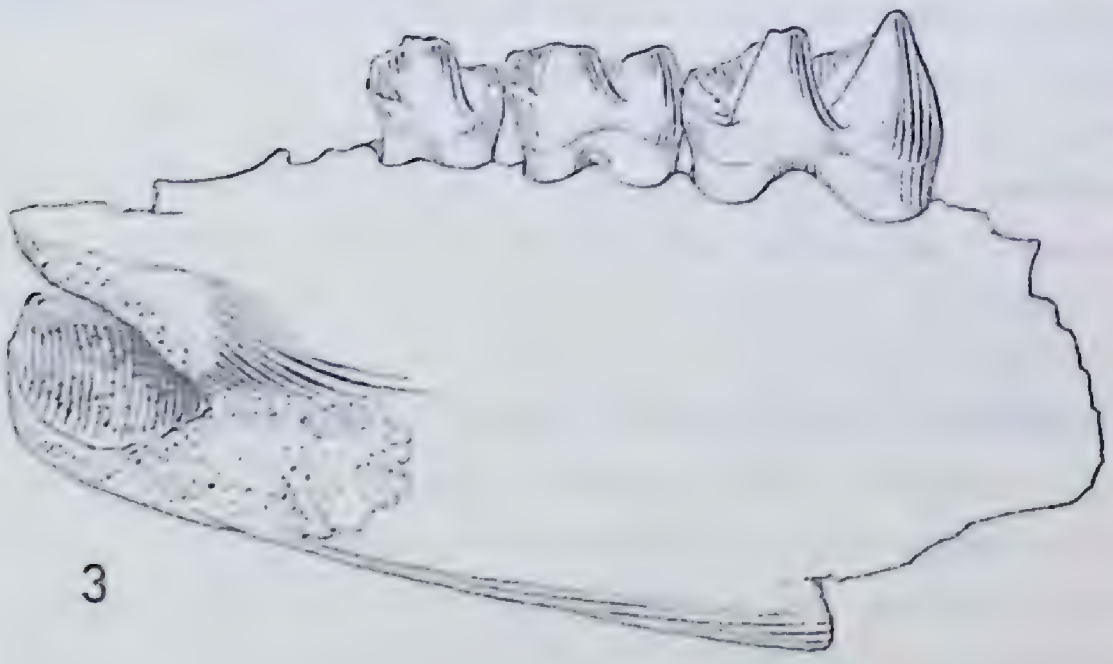

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## CAPTIONS FOR FIGURES

*Toxotherium hunteri*, type, N.M.C. No. 8918, right mandibular ramus with $P\frac{2-4}{}$. Fig. 1, labial view; Fig. 2, crown view; Fig. 3, lingual view, all approximately 1.3 natural size.

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OTTAWA, 1961

Cat. No. R95-5/13

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# Natural History Papers

## National Museum of Canada

DEPARTMENT OF NORTHERN AFFAIRS
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OTTAWA

NUMBER 14 FEBRUARY 6 1962


## MAMMAL TEETH FROM THE ST. MARY RIVER FORMATION (UPPER CRETACEOUS) AT SCABBY BUTTE, ALBERTA

LORIS S. RUSSELL

### INTRODUCTION

The small plateau with dissected western face, situated about three miles east of Nobleford, Alberta, and just south of Kehoe Lake, is known in the geological literature as Scabby Butte (Dawson, 1885, p.79c). The rocks exposed in this isolated patch of badlands are referred to the lower part of the St. Mary River formation, although on the basis of lithology they compare more closely with those of the Edmonton formation of central Alberta. In age these rocks are late but not latest Cretaceous, corresponding to a part of the Campanian sub-stage of western Europe. Dinosaur remains were found here in 1882, and a very interesting assemblage of fossil vertebrates has been obtained here in recent years by expeditions from the National Museum of Canada. This fauna will be the subject of a monograph being prepared by W. Langston, Jr.; the most remarkable member is the bizarre ceratopsian *Pachyrhinosaurus* (Sternberg, 1950).

During the field season of 1957, Dr Langston, in charge of the National Museum field party, discovered a concentrated occurrence of small teeth and bones at one locality in the Scabby Butte badlands. Washing, screening, and sorting of the residue isolated, among various teeth of fish and reptiles, two lower molars of mammals. Subsequently a fragment of a third molar was found. These teeth do not closely resemble the opossum-like lower molars previously found in the Edmonton and Oldman formations, and apparently represent placental mammals. Until now, the oldest-known fossil placentals from North America have been those from the somewhat younger Lance formation.

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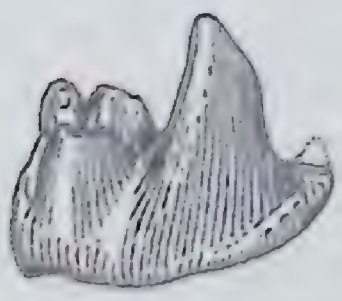
## DESCRIPTION

The best-preserved specimen (National Museum of Canada, Vertebrate Palaeontology Collection No. 9820) is a very small, nearly complete right lower molar (figs. 1–3). The tips of the paraconid, hypoconid, and entoconid are missing. Only the posterior root is present. The protoconid, which is the largest cusp, projects somewhat forward as well as upward. The posterior slope of this cusp has the sweeping curve seen in leptictid lower molars, in contrast to the straight posterior slope of didelphyid teeth. The metaconid is not much smaller than the protoconid and has the same curved posterior slope, the two cusps together providing a single shearing surface to work against the anterior margin of the opposing upper molar. The paraconid, although incomplete, was obviously much smaller than the protoconid or the metaconid and had a marked forward inclination. The anterior cingulum is a narrow shelf along the anteroextemal face of the trigonid. The hypoconulid and the entoconid, although not conjoined, are closer together than are the hypoconid and the hypoconulid.

The second specimen (NMC No. 9821) consists of the trigonid of a left lower molar, without root (figs. 4–6). It represents a distinctly larger tooth than No. 9820, and one with a different cusp structure. The arrangement of the three cusps is that of an isosceles triangle, with large protoconid and smaller, symmetrically arranged paraconid and metaconid. There is a deep internal cleft between the two last-named cusps. In contrast to No. 9820, the posterior slope of the trigonid is nearly straight, and the paraconid projects very little forward but lies close to the metaconid.

The third specimen (NMC No. 9932) is a fragment from the anteroexternal face of the protoconid of a left lower molar. It is intermediate in size between the corresponding parts of No. 9820 and No. 9821. The fragment includes the anterior cingulum and the beginning of the outer edge of the talonid. Except for the smaller size, there is a marked similarity to the corresponding part of specimen No. 9821.



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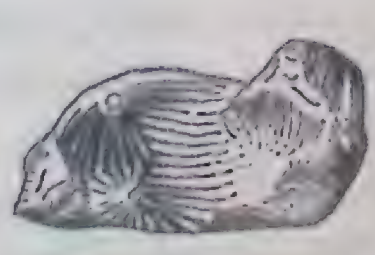

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Figure 1. Leptictid?, lower right molar, NMC No.9820, external view, X 15.
Figure 2. Same, internal view, X 15.
Figure 3. Same, dorsal view, X 15.

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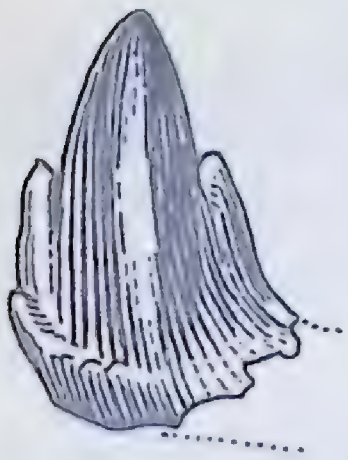

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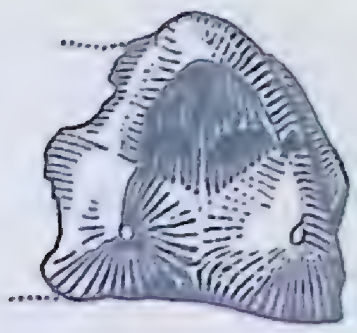

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Figure 4. Miacid?, trigonid of left lower molar, NMC No.9821, external view, X 10.
Figure 5. Same, internal view, X 10.
Figure 6. Same, dorsal view, X 10.

## MEASUREMENTS

No. 9820, length of crown, as preserved ..... 1.6 mm
No. 9820, maximum width at right angles to length ..... 0.9 mm
No. 9821, anteroposterior diameter of trigonid, as preserved ..... 2.1 mm
No. 9821, width of trigonid, at right angles to previous dimension ...2.4 mm

## CONCLUSIONS

Specimen No. 9820 differs from didelphyid lower molars, including those in the Upper Cretaceous fauna, in the strong forward projection of the paraconid, the curved posterior slope of the trigonid, and the greater separation of entoconid and hypoconulid. The anterior cingulum is narrower than in most, but not all, didelphyids. These features are more like the conditions in the lower molars of leptictid insectivores, although the typical leptictid tooth has the hypoconulid more separated from the entoconid than is the case in this specimen. Nevertheless, the closest affinities appear to be with the Leptictidae, and specimen No.9820 is tentatively referred to that family.

Specimen No. 9821 obviously represents a different group of mammals. Its symmetrical trigonid and subequal paraconid and metaconid are not suggestive of either didelphyids or leptictids. Such conditions, however, could have been present in the lower molars of the ancestors of the Paleocene Miacidae, such as *Didymictis*. Specimen No. 9821 is tentatively referred to the Miacidae, and with it is associated Specimen No. 9932.

It is hoped that further work at the Scabby Butte locality, using washing and screening techniques, will yield additional teeth of mammals, particularly upper molars, which might definitely establish the occurrence of placental mammals in this fauna. The somewhat younger Lance fauna includes a number of zalambdodont-like insectivores (Simpson, 1951), and similar forms ought to be present in the St.Mary River – Edmonton

(Edmontonian) fauna. The diversity of placental mammals in the Puercan fauna, at the very beginning of Tertiary time, suggests that the forerunners of placentals other than "insectivores" will be found among the mammals of the uppermost Cretaceous formations.

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OTTAWA, 1962

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# AMPHIPOD CRUSTACEANS OF THE PACIFIC COAST OF CANADA

## II. FAMILY OEDICEROTIDAE

ERIC L. MILLS*

## I. INTRODUCTION AND ACKNOWLEDGMENTS

In the summers of 1955, 1957, and 1959, Dr. E.L. Bousfield of the National Museum of Canada, Ottawa (with the author as field assistant in 1955 and 1957), made collections of intertidal invertebrates on southern Vancouver Island, the Queen Charlotte Islands, northern Vancouver Island, and the mainland of British Columbia. Collections at 125 marine localities yielded the following members of the family Oedicerotidae: *Westwoodilla caecula* (Bate) "caecula" form, *Monoculodes zernovi* Gurjanova, *M. spinipes* n. sp., *Synchelidium shoemakeri* n. sp., and *S. rectipalmum* n. sp.

There are very few records of members of these genera on the North American Pacific Coast. Wailes (1931), in a list of British Columbia plankton, lists *Westwoodilla caecula* Bate and *Monoculodes carinatus* Bate. Wieser (1959) records *W. caecula* and *Synchelidium* spp. intertidally in Puget Sound and *Monoculodes zernovi* intertidally on the ocean coast of Washington. On the western Pacific Coast the Russian workers Gurjanova (1951) and Bulycheva (1951) record *Westwoodilla caecula* and several species of *Monoculodes*, including *M. zernovi* Gurjanova and *M. synophthalmus* Bulycheva, taken in the Sea of Japan.

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Enequist (1950) gives detailed notes on feeding, ecology, and activity of members of the Oedicerotidae. Most members of the family burrow in a sandy or muddy substratum and are deposit feeders. The mouthparts and gnathopods are used in feeding, but not the antennae and pleopods. Despite their burrowing habits, Enequist found that members of the family (including *Westwoodilla caecula)* are active and can swim rapidly. Peraeopods and gnathopods are used in burrowing, and the urosome is bent at right angles to the body, which rests on the antennae, last three pairs of peraeopods and uropods. Setae on antennae, such as those shown laterally and medially

STATION LIST (see FIG. 6)

| Station No. | Locality | Date | Habitat | Salinity ‰ | Temp. °C. | *Westwoodilla caecula* | *Monoculodes zernovi* | *Monoculodes spinipes* | *Synchelidium shoemakeri* | *Synchelidium rectipalmum* |
|---|---|---|---|---|---|---|---|---|---|---|
| F1 | Whiffen Spit, Sooke, V.I., B.C. | 17 Aug., 1955 | Stones, boulders, sandy gravel | 30.4 | 10.9 | | | | X | |
| F3 | Witty's Lagoon, Victoria, B.C. | 16 Aug., 1955 | Sand flats and rock | 30.5 | 11.1 | | | | X | |
| F5 | Dallas Rd., breakwater, Victoria, B.C. | 16 Aug., 1955 | Stone, sand, eelgrass | 30.0 | 10.1 | | | | X | |
| G2 | Campbell River, breakwater, V.I., B.C. | 13 Aug., 1955 | Boulders, sand, algae | 28.8 | 12.5 | | | | X | X |
| P4 | NW end Wickaninnish Bay, V.I., B.C. | 5 Aug., 1955 | Sand pools and rock | 30.2 | 12.5 | | | X | | |
| P6a | SE end Wickaninnish Bay, V.I., B.C. | 2 Aug., 1955 | Sandy beach, rocks | 31.0 | 12.4 | | | X | | |
| P8 | Wreck Bay, V.I., B.C. | 8 Aug., 1955 | Sand and stone beach | | | | | X | | |
| V3 | Nahwitti Bar, Hope I., B.C. | 17 July, 1959 | Sand, kelp, and shells, 30 fath. | | | X | | | X | X |
| V4b | Roller Bay, V.I., B.C. | 22 July, 1959 | Course sand, gravel, boulders, eelgrass | 32.6 | 10.4 | | | | | X |
| V7 | Lady Ellen Pt., V.I., B.C. | 7 Aug., 1959 | Sand, eelgrass, stones, boulders, kelp | | 11.5 | | | | X | |
| V17 | Boat Bay, V.I., B.C. | 5 Aug., 1959 | Sand, stones, rock, eelgrass, kelp | 31.1 | 10.2 | | | | X | |
| V22 | Oyster Bay, V.I., B.C. | 21 June, 1959 | Sand, eelgrass, and pebbles | 27.7 | 10.8 | X | | | X | |
| O3 | Grant Bay, V.I., B.C. | 21 July, 1959 | Sand, shells, and rock | 33.0 | 11.8 | | | X | | |

## Station List (concluded)

| Station No. | Locality | Date | Habitat | Salinity‰ | Temp. °C. | *Westwoodilla caecula* | *Monoculodes zemovi* | *Monoculodes spinipes* | *Synchelidium shoemakeri* | *Synchelidium rectipalmum* |
|---|---|---|---|---|---|---|---|---|---|---|
| O5 | Ferrer Pt., beach, V.I., B.C. | 20 July, 1959 | Rock, sand, and eelgrass | 32.2 | 13.5 | | | | X | |
| O7b | Benson, Pt., Nuchatlitz Inlet, V.I., B.C. | 20 Aug.,. 1959 | Sand and rock faces | | 15.0 | | | | X | |
| O7d | Nuchatlitz Inlet, V.I., B.C., off Benson Pt. 12 – 24 ft. | 19 Aug., 1959 | | | | | | | X | |
| O13 | Yarkais, Vargas I., B.C. | 17 Aug., 1959 | Sand, eelgrass, and rocks | 30.7 | 11.3 | | | | X | |
| N6 | Bremner Beach, Raynor Pt., V.I., B.C. | 2 Aug., 1959 | Fine sand, weed, eelgrass | 32.4 | 10.0 | | | X | | |
| N11 | Port Progress, B.C. | 4 Aug., 1959 | Sand, eelgrass, and rocks | 30.7 | 11.3 | | | | | X |
| H2 | Parry Passage at Kiusta Village, Q.C.I., B.C. | 23 Aug., 1957 | Sand and small shells | | | | | | | X |
| H2a | Parry Passage just E. of Kiusta, Q.C.I., B.C. | 24 Aug., 1957 | Boulders and sand | 31.5 | 12.4 | | | | | X |
| H3 | Off Masset Sd., Q.C.I., B.C. | 27 Aug., 1957 | Sand and gravel | | | | | | | X |
| H8b | Delkatla Slough, Masset, Q.C.I., B.C. | 25 Aug., 1957 | Mud and sand | | | | | | | X |
| H9 | ditto | 27 Aug., 1957 | Mud, stones, eelgrass | | | | | | | X |
| H11 | ½ mi.S.Old Masset, Q.C.I., B.C. | 27 Aug., 1957 | Boulders, eelgrass, sand | 28.5 | 13.6 | | | X | | X |
| E14a | Onward Pt., Moresby I., Q.C.I. | 13 July, 1957 | Exposed rock and boulders | 14.5 | 32.0 | X | | | | |
| E14b | Beach opp. Gillett I., Q.C.I., B.C. | 14 July, 1957 | Sand and boulder beach | 14.5 | 30.6 | X | | | | |
| E14c | Onward Pt., Q.C.I., B.C. | 16 Aug., 1957 | Sand and fine gravel- 15 – 90 ft. | | | X | X | | | |
| W9 | N. side Gudal Bay, Q.C.I., B.C. | 26 July, 1957 | Rock, sand, river mouth | 29.3 | | | | | | X |

on antennae of *Monoculodes spinipes* (Fig. 3) aid in support. As the animal moves forward feeding, the burrow collapses behind. The widened joints of peraeopods and their heavy setation prevent collapse of the area enclosing gills and brood plates under pressure of the substratum. All species examined by Enequist ingested detritus, which was passed from gnathopods to maxillipeds, maxillae, and mandibles.

The author is grateful to Dr. E.L. Bousfield, Curator of Invertebrates, National Museum of Canada, for invaluable advice and criticism and for the use of collections, and to Dr. Thomas E. Bowman of the United States National Museum for preliminary examination of specimens of *Synchelidium*.

KEY TO CANADIAN PACIFIC COAST SPECIES OF OEDICEROTIDAE
(After Stebbing, 1906)

1. Gnathopod 2 chelate, mandibular molar degraded..... *Synchelidium* 2.
   Gnathopod 2 subchelate, mandibular molar not degraded..... 3.
2. Gnathopod 1 palm oblique, basis of peraeopod 5 broad, without long setae on posterior margin..... *Synchelidium shoemakeri* n. sp.
   Gnathopod 1 palm vertical, basis of peraeopod 5 relatively narrow, with long setae on posterior margin..... *Synchelidium rectipalmum* n. sp.
3. Mandibular palp, segment 2 strongly curved, gnathopod 1, Segment 5 only slightly produced distoventrally..... *Westwoodilla*
   Segment 5 of gnathopods long, ending in setose expansion, rostrum strongly arched dorsally, inter-antennal lobe sharp.....*Westwoodilla caecula* (Bate)
   Mandibular palp, segment 2 not strongly curved, gnathopod 1, segment 5 with long apical process..... *Monoculodes* 4.
4. Antenna 2 heavily setose, hind corner of abdominal side plate 2 acute..... *Monoculodes spinipes* n. sp.
   Antenna 2 sparingly setose, hind corner of abdominal side plate 2 rounded.....M. *zernovi* Gurjanova

## II. SYSTEMATIC SECTION

### Family OEDICEROTIDAE Stebbing
Stebbing, 1906: 235

"Side plates of moderate size, fringed with setae. Pleon segments 1–3, posterolateral corners usually rounded. Eyes, when present and distinctly developed, usually contiguous, approximate or wholly confluent, dorsal and more or less frontal. Antenna 1...with accessory flagellum absent or rudimentary. Epistome not projecting. Upper lip not bilobed. Lower lip with inner lobes separate or coalesced. Mandible, molar variable,

palp usually large. Maxillipeds, plates well developed, but seldom large. Gnathopod 1...subchelate. Gnathopod 2...subchelate or rarely chelate. Paraeopods 1–4... 4th joint moderately large. Peraeopods 3 and 4, 2nd joint elliptic, fringed with plumose setae. Peraeopod 5...very long, 2nd joint expanded, 7th stiliform. Branchial vesicles usually simple, large. Uropods 1–3 commonly extending equally far back. Telson small, entire."

## Genus WESTWOODILLA Bate
Stebbing, 1906: 249

"Head with frontal process ending in acute rostrum, usually short. Side plates of moderate size, 4th with lower hind corner not produced, narrower than 5th. Eyes contiguous on frontal process. Antenna 1 shorter than antenna 2, flagellum of antenna 2 very elongate. Upper lip with angular sides. Lower lip, inner lobes well-defined. Mandible strong, cutting edge indistinctly dentate, molar well-defined, palp slender, 2nd joint longest, much curved. Maxilla 1, outer plate carrying 8 spines (Schneider). Maxillipeds, inner plates rather short, outer reaching apex of 2nd joint of moderate-sized palp. Gnathopods 1 and 2 nearly alike, rather feeble, 5th joint long, ending in short setose expansion, 6th rather small, oblong oval. Peraeopods 1–5, uropods 1–3 and telson as in *Monoculodes*".

### Westwoodilla caecula (Bate) (Fig. 1, 6A)

*Westwoodea caeculus* (nomen nudum) Bate 1856, p. 58
*Westwoodia caecula* Bate 1856, p. 140
*Westwoodilla caecula W. hyalina* Bate 1862, pp. 102-103
*Westwoodilla megalops* (G.O. Sars) 1882, p. 96
*Westwoodilla megalops* Dunbar 1954, p. 739

DIAGNOSIS

Characterized by:

1. Segment 5 of both gnathopods long, ending in short setose expansion.
2. Strongly arched rostrum; eye toward distal end of frontal process.
3. Apex of telson broadly rounded, armed with several spinules.
4. Interantennal lobe sharp, not rounded.
5. Segment 2 of mandibular palp curved and expanded proximally, with spinules.

*Male* (6 mm) – Head longer than first three body segments combined; apex of rostrum sometimes slightly upturned, rostrum reaching to end of peduncular segment 2 of antenna 1. Antenna 1, flagellum of 20 articles, extending

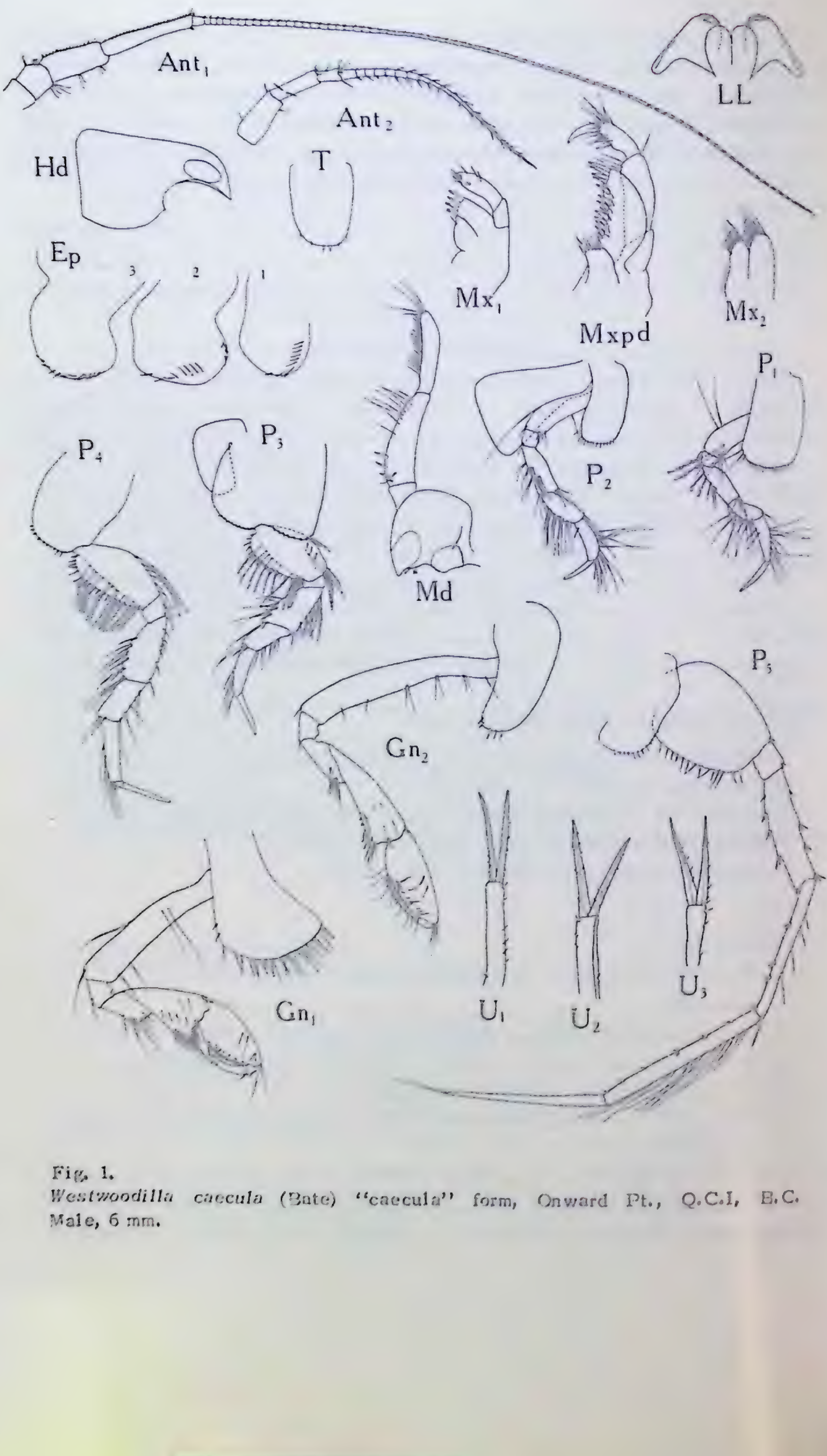


Fig. 1.
*Westwoodilla caecula* (Bate) "caecula" form, Onward Pt., Q.C.I., B.C. Male, 6 mm.

half its length beyond end of peduncle of antenna 2; flagellum of antenna 2 elongate, with about 70 articles.

Mandible, segment 2 of palp rather stout at base, not greatly curved, segment 3 with an even row of short spines distally. Maxilliped, outer plate with 14 teeth; Maxilla 1, outer plate with 9 teeth.

Gnathopod 1, posterodistal expansion of segment 5 with fringe of stout, hooked setae; segment 6, palm rather straight; segment 2 about equal in length to 3, 4, 5, and 6 combined. Gnathopod 2, segment 2 about equal to following segments combined; distal margin of coxal plate with only a few setae.

Peraeopods 1 and 2, segment 2 sparingly setose, dactyl pointing posteriorly. Peraeopods 3 and 4 with long plumose setae on segment 2; dactyl pointing anteriorly. Peraeopod 5 very long, extending posteriorly, segments 6 and 7 with fringe of long setae on medial margin. Gills simple, lobate.

Peraeon rather slender.

Pleopod rami and peduncles subequal; peduncles each with two short, stout coupling spines and a few setae and spinules posterodistally, peduncle of pleopod 2, less stout than in other pleopods; rami rather stout, with long setae.

Uropod 1 outer ramus slightly shorter than inner, margins of rami finely serrated. Uropods 2 and 3, rami serrated, uropod 3 extending slightly beyond anterior uropods. Telson ovate; apex rounded, with several spinules.

*Female* (7 mm) – Head relatively slightly shorter than in male, about equal in length to first three body segments combined. Antenna 1 subequal to antenna 2, flagellum of 10 articles; antenna 2 flagellum very short, of 15 articles. Mandible with only a few setae present on palp segment 3. Gnathopod 1, coxal plate more expanded distally than in male; segment 6 narrower, longer and less oval than in male; segment 2, length equal to following segments combined; segment 5 more elongate, expansion more heavily setose than in male. Gnathopod 2, similar to that of male, but segment 2 more elongate; segment 5 somewhat more stout; coxal plate distal margin heavily fringed with long setae. Oostegites very narrow, club-shaped, fringed with long setae. Peraeon more stout, deeper and wider anteriorly; segments 6 and 7 of peraeopod 5 lacking long setae, segment 2 more quadrate than in male.

*Locality records:* V3 - 1♂, 2♀♀, 2 juv., NMC 3659; V22 - 2 ovig. ♀♀, NMC 3660; E14a - 1 ovig. ♀, NMC 3661; E14b - 1♂, NMC 3662; E14c - 9♂♂, 20♀♀, 12 juv., NMC 3663.

REMARKS

This species, previously recorded from the Pacific Coast by Wailes (1931) and Wieser (1959) as *Westwoodilla caecula*, is abundant on both

sides of the North Atlantic, in Greenland, the Gulf of St. Lawrence, and Barents Sea (Dunbar, 1954). Gurjanova (1951) mentions records from the eastern part of the Japan Sea.

Recent material from the Pacific Coast of Canada agrees with Sars (1892) figures of *W. caecula (Halimedon Mulleri)* in most respects, differing in having fewer spines on mandibular palp segment 2, more oblique margin of maxilla 1 inner plate, fewer setae on peraeopods, gnathopod palms straighter, segment 6 of peraeopod 5 relatively longer, and antenna 1 of male less setose. It differs from Stebbing's (1906) description and Sars' figures of *W. megalops* in several respects, especially in having smaller eyes, a wider second segment of the mandibular palp, somewhat dissimilar gnathopods, second joint of peraeopod 5 more rounded than quadrate, and telson rounded, not quadrate. Stephensen (1931) maintained the distinction between *W. caecula* and *W. megalops*, using as distinguishing marks:

1. Telson – rounded in *W. caecula*, truncate in *W. megalops*.
2. Peraeopod 5 segment 2 – upper corner evenly rounded in *W. caecula*, nearly rectangular in *W. megalops*.
3. Antennae – shorter in *W. megalops*.
4. Body – much stouter in *W. megalops* than *W. caecula*.

Dunbar (1954) has fused *W. megalops* and *W. caecula*, giving the former name priority, on the basis of specimens from the Canadian Eastern Arctic and Gulf of St. Lawrence, which combine characters of both previous species. He suggests that the terms "caecula" form or "megalops" form be used to indicate differences in populations. However, as the name *W. caecula* has priority, it must now be used for the species.

Dunbar concludes that North American material resembles the "megalops" form. However the collections from the Canadian Pacific Coast come closest to the "caecula" form, differing from it in features mentioned above, in having a slightly stouter body and, in a few specimens, more quadrate shape of the second segment of peraeopod 5. In the collection from station E14c the shape of this segment is more quadrate in females than in males, approaching the shape of the segment as shown by Stephensen (1931) for *W. caecula*. Setation of this segment is intermediate between that shown by Stephensen for *W. megalops* and *W. caecula*.

Head shape in the "caecula" form appears to be quite variable. Material from the present five stations differs from that illustrated by Sars (1892) and Stephensen (1931) in having a more acute interantennal projection and resembles some forms collected in the Skagerrak and illustrated by Enequist (1949). It may be best to use characters other than head shape to distinguish species of this genus. Very extensive collections from northern seas are probably necessary to reveal limits of variation in morphological characters and to clear up the status of the present "forms" of *W. caecula*.

The "caecula" form from the Canadian Pacific Coast partly resembles *W. rectirostris* (Della Valle) but differs in lacking the upturned rostral apex in the less stout 3rd segment of the mandibular palp, and in the less oblique margin of the 1st coxal plate. Bulycheva (1952) records *W. oxyrhyncha, W. rectangulata,* and *W. asinuata* from the Japan Sea, none of which are close to the "caecula" form.

This species, which occurred intertidally at three stations (V22, E14a, E14b), was dredged at two (V3 and E14c) in 30 fathoms and 15 to 90 feet respectively. Temperature and salinity records indicate a preference for cool polyhaline to marine waters, and, as with most members of the family, this species occurs on sand bottoms.

## Genus MONOCULODES Stimpson

Stebbing, 1906: 258

"Head produced to a rostrum which is usually deflexed, acute. Side plates 4 and 5 rather large. Eyes almost always contiguous, at base of rostrum. Antenna 1 generally much shorter than antenna 2, flagellum of latter in ♂ filiform. Mandible, molar with triturating surface. Maxilla 1, with 9 (6?, 7?) spines on outer plate. Gnathopod 1 . . . usually shorter and stouter than gnathopod 2 . . . 5th joint of latter produced into a long slender process. Peraeopods, uropods, and telson nearly as in *Oediceros.*"

### Monoculodes zernovi Gurjanova (Fig. 2, 6B)

*Monoculodes zernovi* Gurjanova 1936, p. 301

*Monoculodes zernovi* Gurjanova 1951, p. 566, fig. 374, A, B.

DIAGNOSIS

Characterized by:

1. Rostrum long, narrow behind the eyes, extending beyond end of 1st segment of antenna 1.
2. Lobe of segment 5 of gnathopod 1 extending to posterior end of palm.
3. Lobe of segment 5 of gnathopod 2 extending beyond posterior margin of palm. Hand quadrate, narrower distally.
4. Lower margin of coxa of peraeopod 1 rounded, not emarginate.
5. Segment 5 of peraeopod 2 truncate, not expanded distally.
6. Antenna 1, peduncular segment 3 about half length of segment 2.
7. Telson with several very short spinules.
8. Head aspect long and narrow, interantennal angle acute.

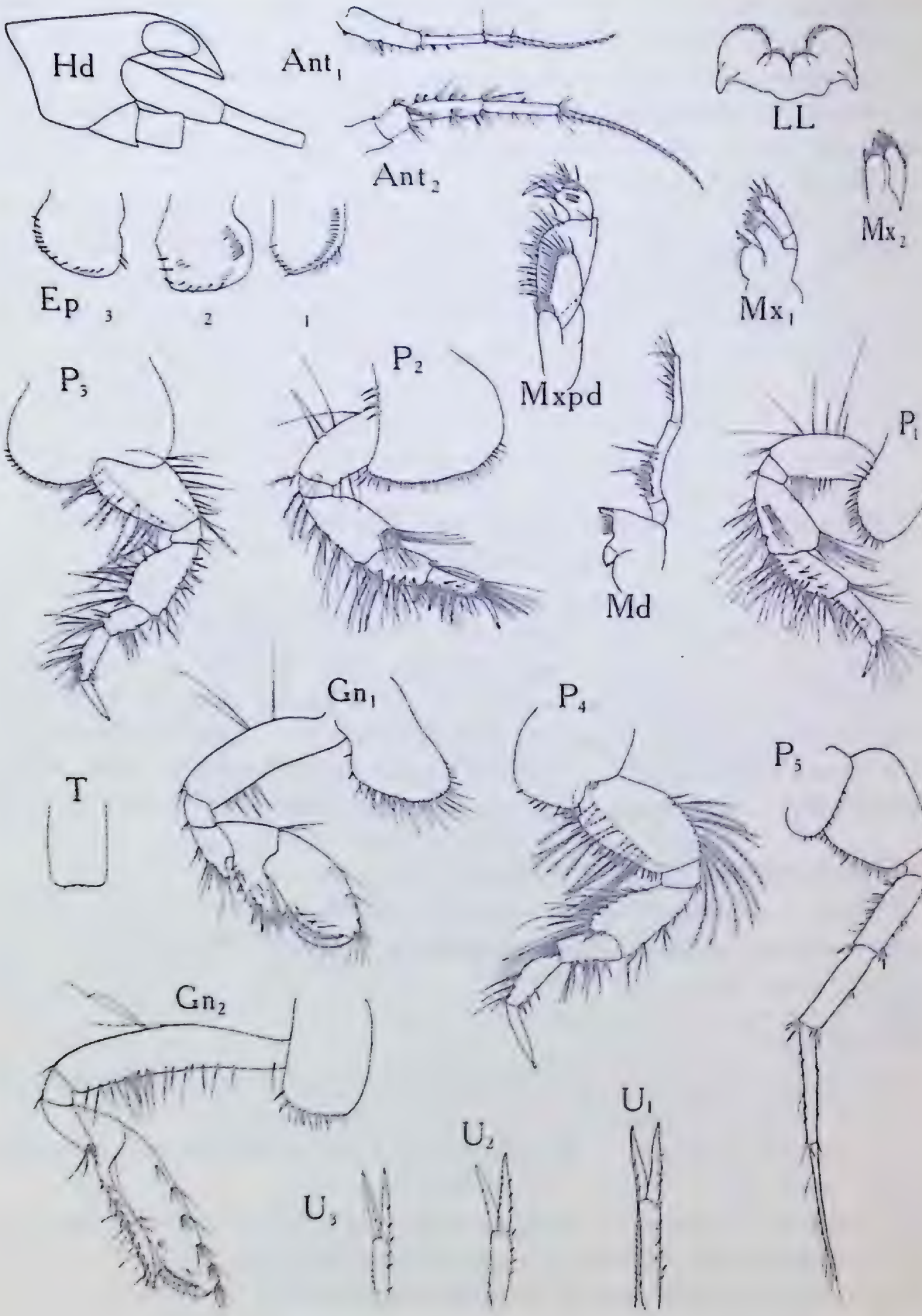


Fig. 2.
*Monoculodes zernovi* Gurjanova. Onward Pt., Q.C.I., B.C. Female, 7.5 mm, imm.

*Female* (7.5 mm, imm.) – Head slightly longer than first three peraeon segments combined. Flagellum of antenna 1 extending just beyond end of peduncle of antenna 2, flagellum of 12 articles; flagellum of antenna 2 of 18 articles.

Maxilla 1, outer plate with nine rather long spines. Maxilla 2, outer plate with a few small spines on outer margin. Mandible, 3rd joint of palp rather long, molar well developed.

Gnathopod 1 palm curved, segment 2 with row of spines at anterodistal end. Gnathopod 2 hand somewhat narrowed distally.

Segment 7 of first four peraeopods terminating in a small beaded process. Peraeopods 1 and 2, segment 7 rather small. Segment 7 of peraeopods 3 and 4 as long as 6th, lanceolate. Fourth peraeopod longer than previous pair. Peraeopod 5 very long, stout, extending beyond urosome. Gills all simple, lobate, those of peraeopod 5 rather small, more quadrate than others.

Peraeon slender, deepest at attachment of 3rd and 4th peraeopods.

Pleon segments 3, 4, and 5 dorsally ridged longitudinally.

Uropod rami rather short, outer slightly subequal to inner, rami of all three extending to same point. Telson slightly emarginate, with a few tiny spinules. Peduncle of pleopods rather stout, subequal to rami, with a longitudinal row of setae; coupling spines 2, short and stout; rami subequal, with long setae.

Male not found.

*Locality record:* E14c – 15 juv., NMC 3657.

REMARKS

This species, described by Gurjanova (1938) from the Japan Sea and later recorded (1951) from the Sea of Japan and Sea of Okhotsk, has been recorded from Puget Sound and the ocean coast of Washington by Wieser (1959). In length of rostrum and placement of the eyes it resembles *Monoculodes borealis* Boeck (Sars, 1895) and *M. breviops* Bulycheva (Bulycheva, 1952). The present species may be distinguished from *M. borealis* by the spinous anterior projection on segment 4 of gnathopod 1, the narrower lobe of segment 5 of gnathopod 2 which extends beyond the posterior end of the palm, the distally rounded 3rd coxal plate, lack of expansion of segment 5 of peraeopod 5, more quadrate and less emarginate telson, more evenly-curved rostrum, and more acute interantennal lobe.

From *M. breviops* it differs in the longer and more narrow rostrum which reaches past the end of peduncular segment 1 of antenna 1, in the shorter interantennal lobe of the head, in having segment 3 of the peduncle of antenna 1 not over half the length of segment 2, in having only a few tiny spinules on the telson, and in having the lobe of segment 5 of gnathopod 2 extending well beyond the posterior end of the palm.

The fifteen specimens of this species were dredged in 15 to 90 feet, probably in the sandier areas sampled. *Westwoodilla caecula* was also taken at this station. Gurjanova reports the species from 47 to 120 metres in the Sea of Japan. Since only a few of the specimens showed well-developed brood plates and since none had reached the length of 15 mm given by Gurjanova, the breeding season of this species may be late in the year.

**Monoculodes spinipes n. sp.** (Fig. 3, 6 C)

DIAGNOSIS

Characterized by:

1. Rostrum short not vaulted, apex acute.
2. Body somewhat flattened dorsoventrally, strongly pigmented on dorsum and coxal plates.
3. Second abdominal side plate pointed posterodistally.
4. Second segment of peraeopod 5 produced into rounded posterodistal lobe; second segment of peraeopod 3 somewhat lobate posterodistally.
5. Antennae very setose; 4th peduncle segment of antenna 2 with group of strong spines near distal end.
6. Lobe of gnathopod 1 segment 5 lanceolate.

*Female* (9 mm, ovigerous) – Head a little longer than first two body segments combined; strong pigmentation on interantennal lobe. Antennae setose, antenna 1, flagellum of 15 articles, extending a little beyond end of antenna 2 peduncle; antenna 2 flagellum of 20 articles.

Maxilla 1, outer plate with nine long spine-like teeth. Maxilliped dactyl rather stout.

Hand of gnathopod 1 ovate, end of dactyl hidden in indentation at end of palm.

Dactyls of first four peraeopods with a small beaded terminal process; dactyls of peraeopods 1 and 2 very short, inconspicuous; dactyls of peraeopods 3 and 4 rather oval, about half as long as preceding segment; peraeopod 5, distal segments heavily set with small spines, second segment often with small notch just above posterodistal lobe. Gills all simple, those of gnathopod 2 to peraeopod 3 lobate, that of peraeopod 4 smaller and quadrate.

Peraeon dorsum rather broad, flattened, heavily pigmented.

Segments 3, 4, and 5 of pleon dorsally ridged longitudinally.

Uropods 2 and 3 projecting slightly beyond uropod 1; outer ramus of uropod 1 shorter than inner ramus, both rami pointed apically. Terminal setae of telson usually pointed upwards. Peduncles of pleopods stout, each with two short stout coupling spines; rami and peduncles subequal.

Male not found.

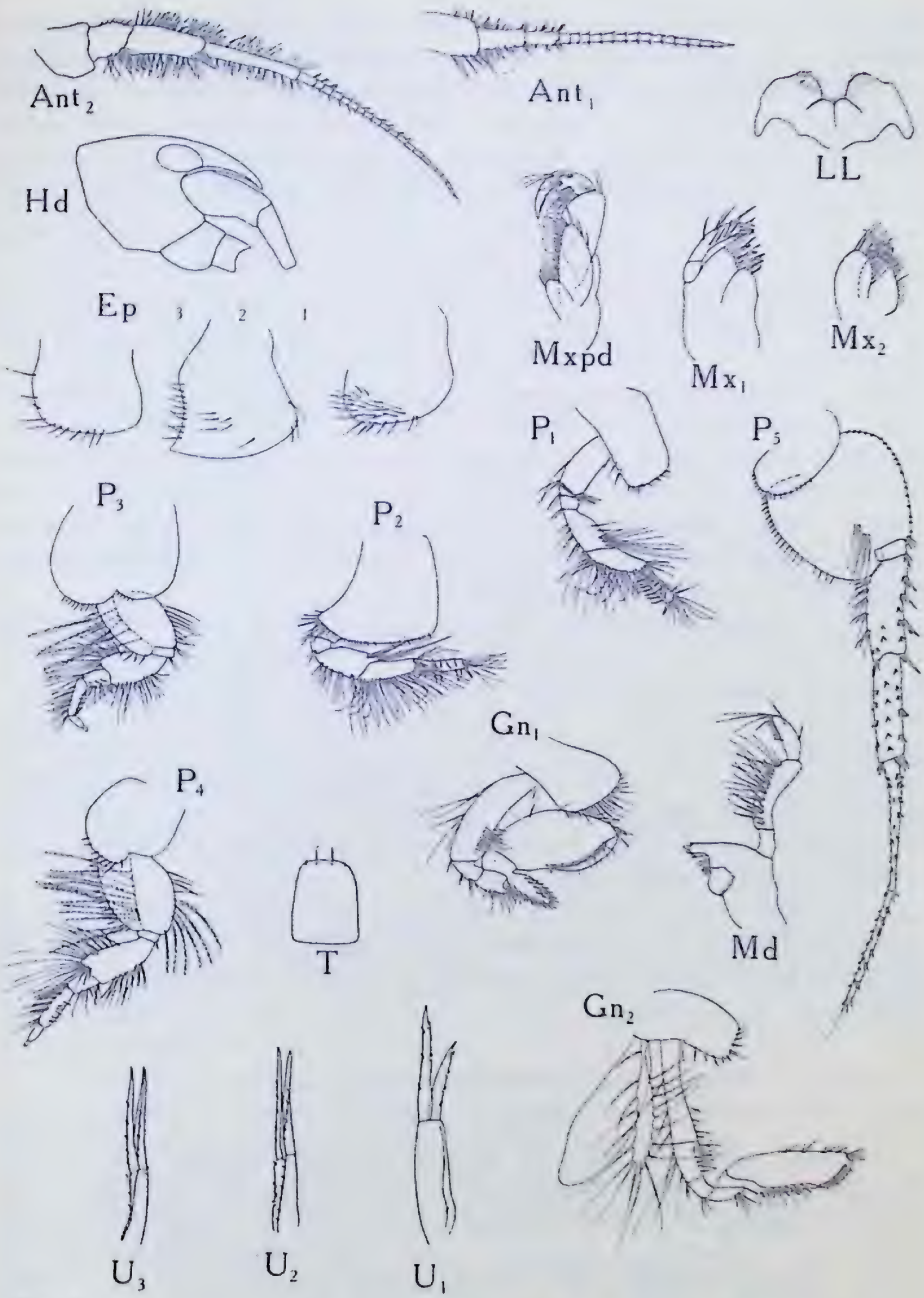


Fig. 3.
*Monoculodes spinipes* n. sp. Grant Bay, V.I., B.C. Female, 9 mm, ovig. (Type).

*Locality records:* P4-7 juv., NMC 3658; P6 a - 11 juv. NMC 3652; P8-1 ovig. ♀, 1 juv., NMC 3653; O3-1 ovig. ♀ type, 3 ♀♀ (1 ovig.) paratypes, NMC 3654; N6-2♀♀ (1 ovig.), 27 juv., NMC 3655; H11-1 ovig. ♀, NMC 3656.

REMARKS

This species comes closest to Bulycheva's (1952) description of *Monoculodes synophthalmus* from sandy areas in littoral and upper sublittoral in the Sea of Japan in the size and shape of the rostrum, heavy pigmentation of the body, the lanceolate process of segment 5 of gnathopod 1, dorsoventral flattening of the body, and lanceolate-ovate claws of peraeopods 3 and 4. It differs from it in several respects, chiefly: the greater length of antenna 1, the first peduncular segment of antenna 1 greater than three-quarters the length of the second; segment 7 of peraeopods 1 and 2 less than half the length of segment 6; length 9 to 16 mm rather than Bulycheva's report of living specimens 8 to 9 mm; presence of spines on last peduncular segment of antenna 2 and the distal segments of peraeopod 5 (not mentioned by Bulycheva); rounded rather than somewhat pointed posterodistal lobe of peraeopod 5; and dorsal longitudinal ridging of segments 3, 4, and 5 of the pleon.

*M. dembiensis* Bulycheva appears to be close to the present species but differs from it in having a stouter and shorter rostrum, a non-lanceolate process of segment 5 of gnathopod 1, much less setose antennae, a longer interantennal angle, and a pointed 7th segment of peraeopod 5. *M. dembiensis* was described from a single lot, and upon study of more specimens might be proved to be a form of *M. synophthalmus*. Bulycheva's description of these species does not stress the characters found most significant in *M. spinipes* above, hence re-examination of Bulycheva's material is desirable to reveal clear-cut differences.

Specimens of *M. spinipes* were taken intertidally in sandy pools or on sand flats where temperatures were rather low (10.0 – 13.6°C) and salinities polyhaline to marine; ovigerous females were found in July and August.

## Genus SYNCHELIDIUM G.O. Sars

Stebbing, 1906: 241

"Head with more or less strongly deflexed rostrum. Side plate 1 distally expanded, with straight lower margin, 4th and 5th rather large. Eyes contiguous, at base of rostrum. Antenna 1 in ♀ longer than antenna 2, 3rd joint rather long. Antenna 2 in ♂ very elongate. Mandible, molar small, conical, tipped with... 1 spine, 3rd joint of palp in ... small.

Maxilla 1 as in *Pontocrates*.... Maxilla 2, plates short, outer apically truncate. Maxillipeds, outer plates with only a few strong spines. Gnathopod 1 powerful, nearly as in *Pontocrates*, but process of 5th joint tipped by a strong spine, palm coarsely dentate. Gnathopod 2, process of 5th joint coalesced with 6th, except near the small chela, in which thumb and finger are both narrow. Other parts in agreement with *Pontocrates*."

**Synchelidium shoemakeri** n. sp. (Fig. 4, 6A)

DIAGNOSIS

Characterized by:

1. Acute posterodistal corner of 2nd abdominal side plate.
2. Palm of gnathopod 1 oblique.
3. Basis of peraeopod 5 broad, posterior margin with very short setae.
4. Head strongly vaulted, apex of rostrum downturned, antennal sinus deep.
5. Outer plate of maxilliped with seven rather short spines.

*Male* (3½ mm) – Head a little longer than first two body segments combined, strongly vaulted, apex of rostrum short and downturned. Flagellum of antenna 1 fringed with setae dorsally, of seven articles. Flagellum of antenna 2 of 52 articles.

Maxilla 1, outer plate with seven long spine-like teeth. Maxilliped outer plate with seven rather short spines.

Gnathopod 1, hand rather narrow, palm oblique, set with small spines; projection of carpus extending considerably beyond lower end of palm; coxa rather narrow, slightly expanded distally. Gnathopod 2 rather slim, chela about one-seventh total length of propodus; coxa rounded distally.

Dactyl of peraeopods 1 and 2 minute. Posterodistal corner of peraeopod 2 coxa acute and projected, with apical spine. Dactyl of peraeopods 3 and 4 conspicuous; coxa of peraeopod 4 projected anterodistally. Peraeopod 5 flexed posteriorly, basis broad, with a rounded posterodistal lobe, hind margin straight, with minute fringing setae. Gills all simple. Peraeon rather narrow.

Pleon segment 3 projecting slightly over urosome mid-dorsally. Pleopod peduncles stout, subequal to rami, coupling spines very small, double-toothed. Abdominal side plate 2 acute posterodistally.

Uropods narrow, both margins of rami finely serrated; 1st extending slightly beyond others, 2nd extending beyond 3rd. Telson narrow, slightly truncate and rounded distally.

*Female* (3½ mm, ovig.) – Antenna 1 projecting beyond antenna 2, dorsal fringing setae of flagellum lacking. Antenna 2, ventral setae of peduncle somewhat longer than in male; flagellum of five articles. Gnathopods very similar to male. Oostegites narrow, club-shaped, fringed with long setae toward the ends.

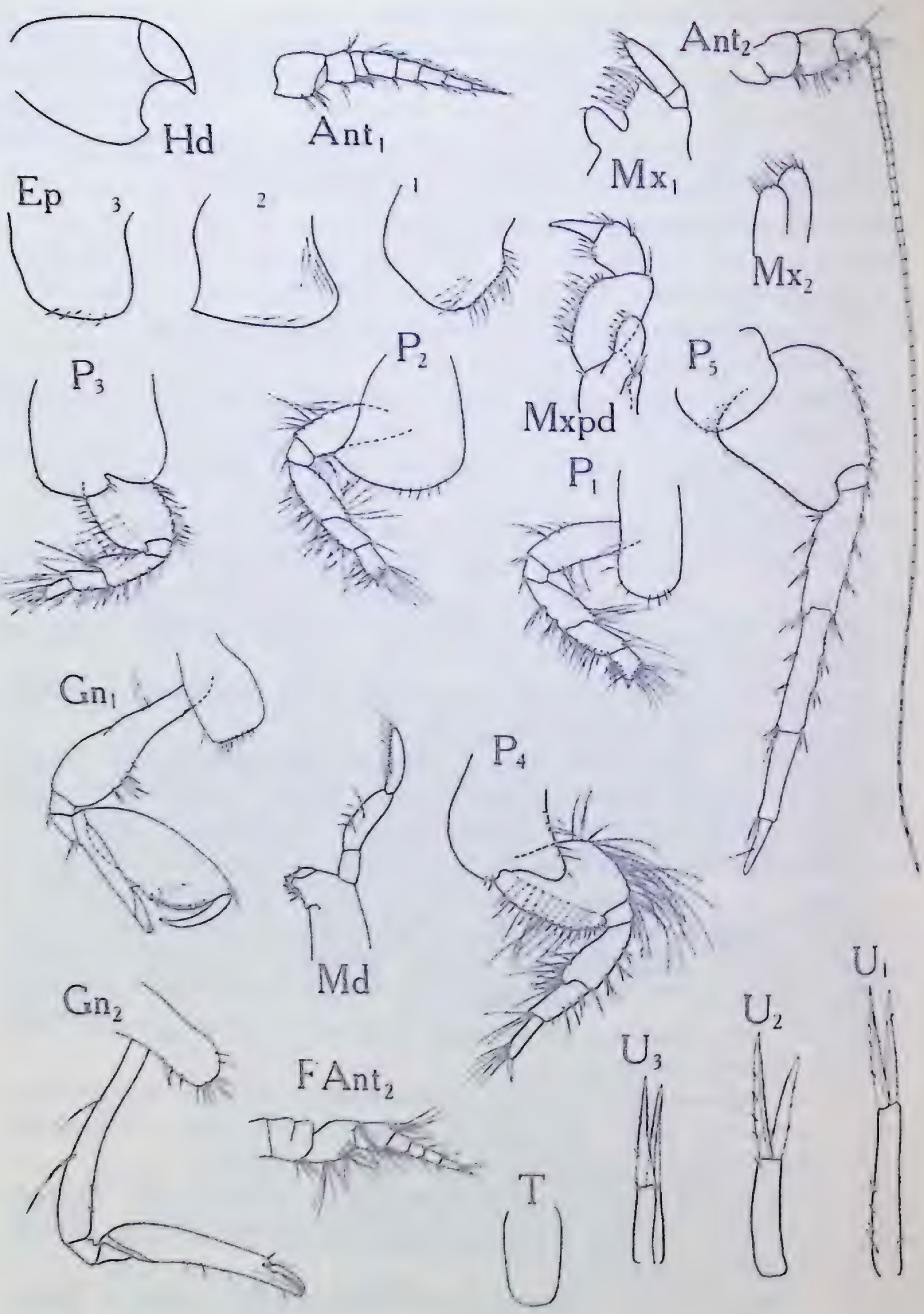


Fig. 4.
*Synchelidium shoemakeri* n. sp. Boat Bay, V.I., B.C. Male, 3.5 mm (Holotype).

*Locality records:* F1-1 ovig. ♀, NMC 3664; F3-13 ovig. ♀♀, 1 imm. ♀, NMC 3665; F5-2♀♀ (1 ovig.), NMC 3666; G2-1 ovig. ♀, NMC 3667; V3-1 imm. ♀, NMC 3668; V7-2 ovig. ♀♀, NMC 3670; V17-1♂ holotype, 1 ovig. ♀ allotype, 4 ovig. ♀♀ paratypes, NMC 3671; V22-14 ovig. ♀♀, NMC 3672; O5-2 ovig. ♀♀, NMC 3673; O7b-8 ovig. ♀♀, NMC 3674; O7d-1 imm. ♂, 1 ovig. ♀, NMC 3675; O13-1 ovig. ♀, NMC 3676; W9-1 ovig. ♀, NMC 3904.

REMARKS

This species differs from all other species of the genus in having an acute posterodistal projection of abdominal side plate 2 and very short setae on the posterior margin of the basis of peraeopod 5. It differs from *S. intermedium*, *S. tenuimanum*, and *S. haplocheles* in having the end of the telson slightly rounded rather than emarginate, and from *S. maculatum* in the more down-curved rostrum, straight posterior margin of the basis of peraeopod 5, and posterodistal projection of the coxa of peraeopod 2. *S. longidigitatum* may be distinguished by its more rounded telson with apical setae, and the long setae of the basis of peraeopod 5.

Ecological data suggest that this species occurs in shallower water than does *S. rectipalmum*, but salinity, temperature, and habitat requirements appear to be quite similar in the two species.

The species is named in honour of the late Mr. C.R. Shoemaker, whose life-long study of amphipod crustaceans will remain an inspiration to his successors.

**Synchelidium rectipalmum** n. sp. (Fig. 5, 6B)

DIAGNOSIS

Characterized by:

1. Palm of gnathopod 1, propodus almost perpendicular to lower margin
2. Basis of peraeopod 5 rather narrow, posterior margin with long setae.
3. Head not strongly vaulted; rostral apex not strongly downturned, rather blunt; antennal sinus shallow.
4. Outer plate of maxilliped with nine rather long spines.

*Male* (3½ mm) – Head slightly longer than first two body segments combined, not strongly vaulted, rostral apex rather blunt and not sharply downturned; antennal sinus shallow. Antenna 1, peduncular segment 1 equal in length to segments 2 and 3 combined; flagellum of seven articles, fringed with setae dorsally. Antenna 2, flagellum of 42 articles.

Maxilla 1, outer plate with seven long spine-like teeth. Maxilliped, outer plate with nine rather long spines.

Gnathopod 1, hand broadly ovate, palm almost at right angles to lower margin of hand; projection of carpus extending just beyond lower

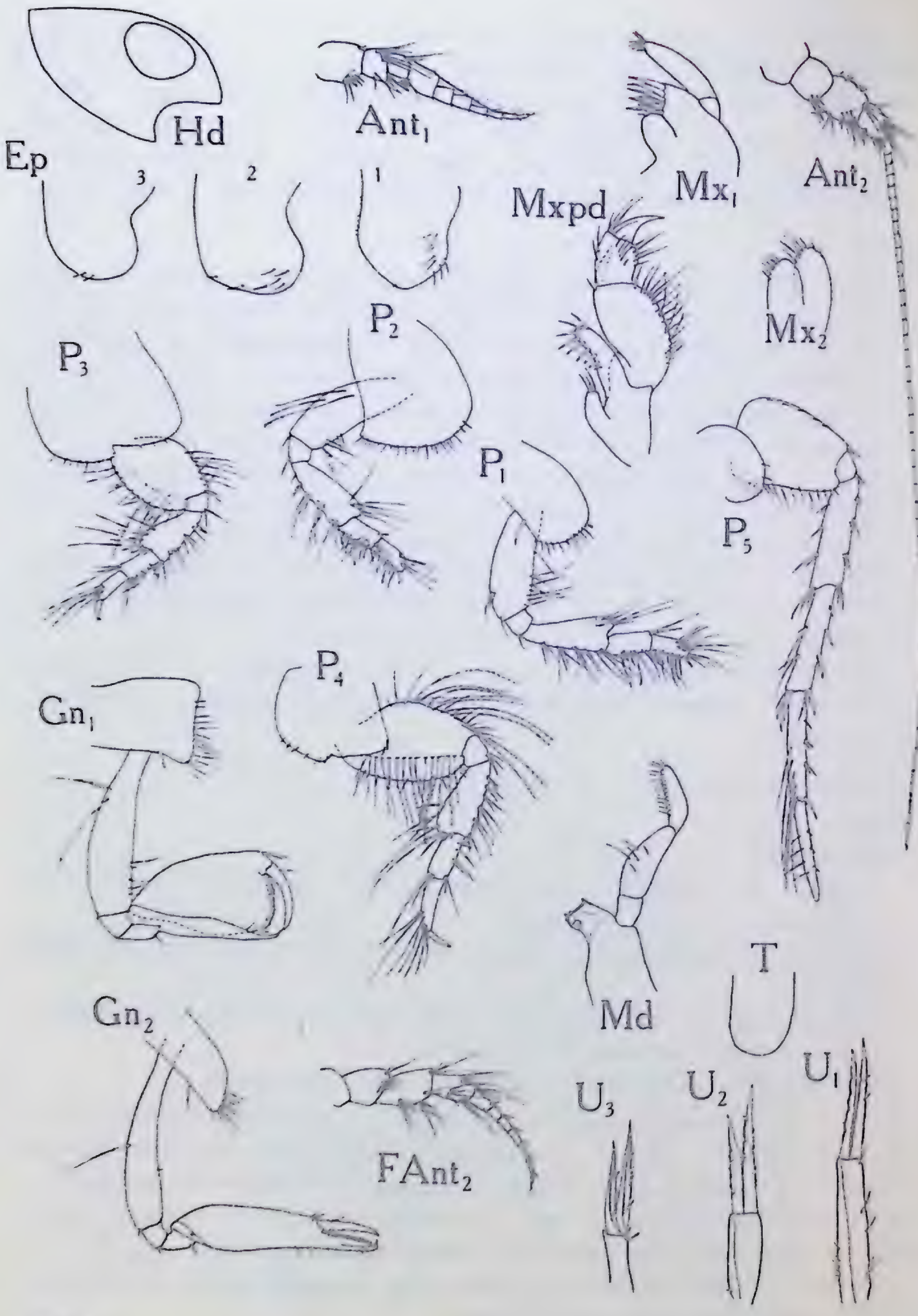


Fig. 5.
*Synchelidium rectipalmum* n. sp. Parry Passage, Q.C.I., B.C. 3.5 mm (Cotypes ♂♂).

end of palm; coxa broad, slightly expanded distally, posterior margin with one stout spine. Gnathopod 2, rather stout and only slightly tapered; chela about one-quarter length of propodus; coxa rather narrow, distal margin slightly oblique.

Peraeopods 1 and 2 with small dactyl. Posterodistal corner of peraeopod 2 coxa projected posterodistally. Dactyl of peraeopods 3 and 4 conspicuous. Peraeopod 5 flexed posteriorly; basis rather narrow, with small rounded posterodistal lobe, hind margin straight, with long setae; propodus with several long plumose setae posteriorly. Gills all simple.

Peraeon rather narrow.

Pleopod peduncles rather stout, subequal to rami, coupling spines very small, double-toothed. Abdominal side plate 2 rounded posterodistally.

Uropods narrow, 1st projecting slightly beyond others, 1st and 3rd projecting beyond 2nd; margins of rami finely serrated. Telson narrow, not truncate, end slightly rounded.

*Female* (4 mm, ovig.) – Antenna 1, first segment of peduncle subequal to 2nd and 3rd combined; flagellum lacking dorsal fringe of setae. Antenna 2 longer than antenna 1, setae of peduncle longer than in male; flagellum short, of seven articles. Gnathopods very similar to male, but coxa of gnathopod 2 with two stout spines on posterior margin. Oostegites narrow, club-shaped, fringed with long setae toward ends.

*Locality records:* G2 - 2♂♂, 2♀♀, NMC 3667; V3 - 1 ovig. ♀, NMC 3668; V4b - 3 imm. ♂♂, NMC 3669; N11 - 1 ovig. ♀, NMC 3677; H2 - 2♂♂, 1 ovig. ♀ cotypes, 4 ♂♂, 7 ovig. ♀♀, 13 imm. ♀♀ paratypes, NMC 3678; H2a - 2 imm. ♂♂, NMC 3679; H3 - 2 ovig. ♀♀, NMC 3680; H8b - 1 imm., NMC 3681; H9 - 1 imm. ♂, NMC 3682; H11 - 3 imm. ♂♂, 1 ovig. ♀, 2 imm. ♀♀, NMC 3683.

REMARKS

This species may be distinguished from all others of the genus by the perpendicular palm of the hand of gnathopod 1. It differs from *S. shoemakeri* in the following characters: flagellum of antenna 1 has 42 rather than 52 articles; antenna 2 of the female extends beyond antenna 1 rather than the reverse; the maxilliped outer plate has nine long spines rather than seven short ones; peraeopod 5, basis is narrow, posterior margin with long setae, rather than broad and with very short setae; posterodistal margin of epimeral plate 2 is rounded and not acute; telson broader and the end more rounded; head less vaulted, rostral apex more blunt and less downturned; and antennal sinus shallower.

Ecological requirements of *S. rectipalmum* and *S. shoemakeri* appear to be quite similar, but the present species probably occurs in deeper water since it was dredged at three stations.

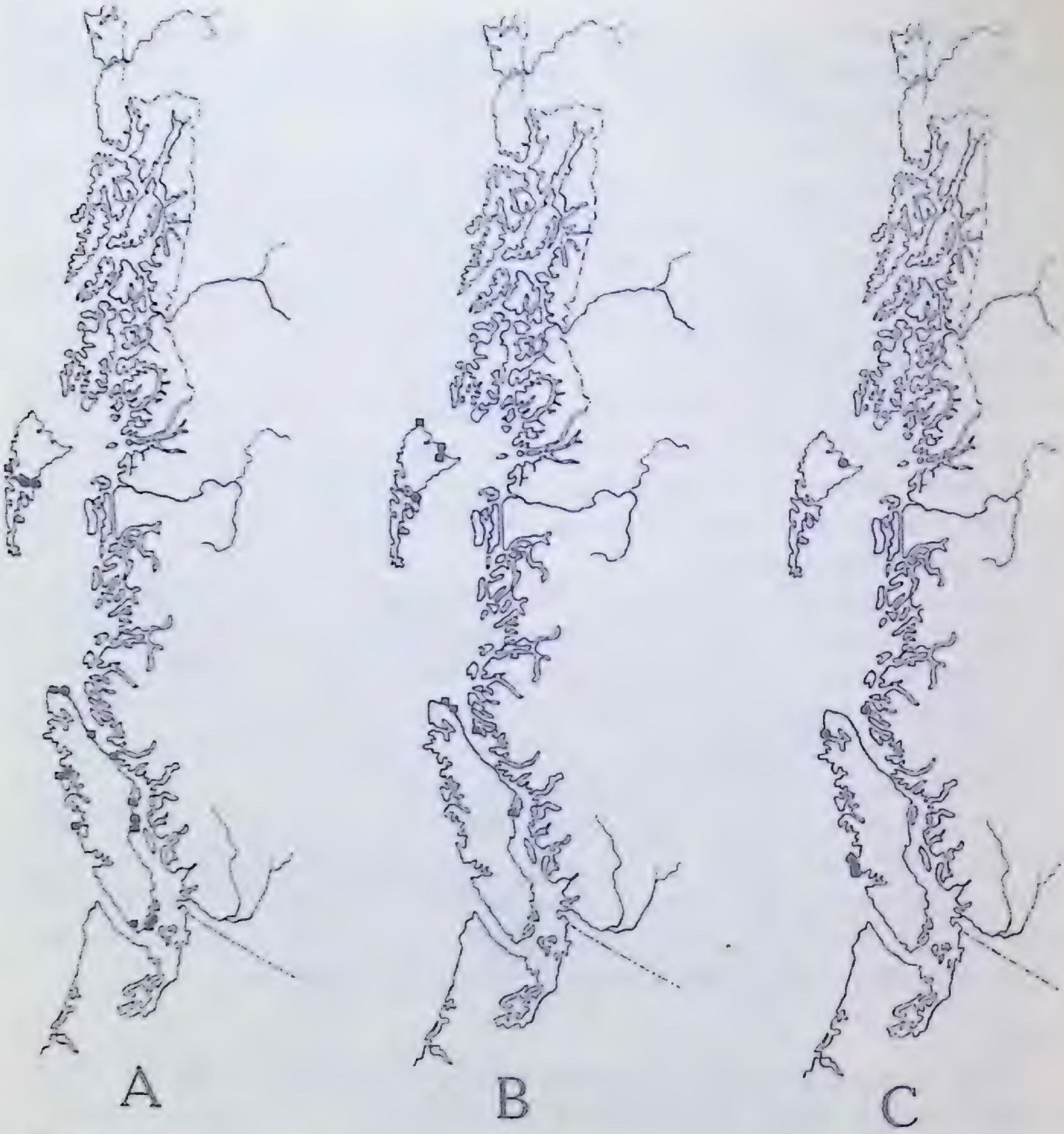


Fig. 6.
Distribution of species of Oedicerotidae on the Canadian Pacific Coast.
A. *Westwoodilla caecula* "caecula" form (circles), *Synchelidium shoemakeri* (squares); B. *Monoculodes zernovi* (circle), *Synchelidium rectipalmum* (squares); C. *Monoculodes spinipes*.

Abbreviations for figures –

| | | | |
|---|---|---|---|
| Ant | – Antenna | Mx | – Maxilla |
| Ep | – Epimeral plate(s) | Mxpd | – Maxilliped |
| An | – Gnathopod | P | – Peraeopod |
| Hd | – Head | T | – Telson |
| LL | – Lower lip | U | – Uropod |
| Md | – Mandible | F Ant | – Antenna of female |

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# Natural History Papers

## National Museum of Canada

DEPARTMENT OF NORTHERN AFFAIRS
AND NATIONAL RESOURCES

OTTAWA

NUMBER 16 MAY 9 1962


# A CLIMATIUS-LIKE SPINE FROM THE STONEHOUSE FORMATION, UPPER SILURIAN, NOVA SCOTIA


D. L. DINELEY*



## ABSTRACT

A single large acanthodian spine resembling *Climatius* is recorded from the Upper Silurian Stonehouse formation in the Arisaig Series of Nova Scotia. It appears to be from a lower horizon than previous Canadian specimens. Like other Silurian occurrences of *Climatius*, it is associated with marine invertebrates, but this does not necessarily imply that *Climatius* inhabited the sea; the acanthodians had already made their appearance in non-marine environments.


## INTRODUCTION

Many years ago Whiteaves (1897) described very briefly a fish tooth from the "Upper Arisaig series" at McDonald's Brook, Antigonish County, Nova Scotia, and believed it to be a crossopterygian, probably allied to *Holoptychius*. The horizon is very low indeed for such a fossil, and further specimens would be very welcome. A search for fossil fish remains in the Arisaig series in 1961, during field work for the National Museum of Canada, revealed no new dendrodont teeth, though acanthodian spines were found in the "Red Stratum" and in the Stonehouse formation.

A spine from the Stonehouse formation is tentatively referred to *Climatius*, a genus which undoubtedly includes a wide range of spines that might more properly be distributed amongst several genera. The Stonehouse formation has been correlated with the Upper Ludlow Series of Britain (McLearn, 1924) and more recently with the "Downtonian


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Series" (Copeland, 1960). *Climatius* is known in the Downtonian of England and Wales and also in the Oved-Ramsasa Beds of Scania, Southern Sweden (Upper Ludlow – Lower Downton) and the Beyrichienkalk of Northern Germany (Gross, 1947). Though many specimens of "*Climatius*" have been collected from the Downtonian and Dittonian of Britain, the identification of more than a few may be somewhat suspect. The records of this genus from the Lower Devonian of Campbellton, New Brunswick (Whiteaves, 1889), seem to be correct. Closer by, it has been recovered from the Knoydart formation (Lower Devonian) of McAras Brook, Nova Scotia (Denison, 1955).

The present specimen (National Museum of Canada No. 10011) was obtained from three inches of light grey, shell-packed calcareous siltstone or sandstone, stratigraphically some 400 feet above the top of the "Red Stratum." The locality is on a small headland approximately half-way between the outcrop of the "Red Stratum" and the mouth of Stonehouse Brook on the coast west of Arisaig, Antigonish County, Nova Scotia (Canada, National Topographic Series, Map 11 E 16, Malignant Cove). No other identifiable vertebrate remains have been found in this stratum.

## DESCRIPTION

The fossil (fig. 1.) consists of the greater part of a spine lying on its left side. It is laterally compressed and gently curved throughout, except in the proximal quarter. Some two-thirds of the exposed side has been destroyed by erosion. The spine bears longitudinal ribbing similar to that in *Climatius*. There are four "ribs" on the anterior part of the spine which show a distinct tendency to break into distally-pointed, blunt denticles of low relief (.5 mm).

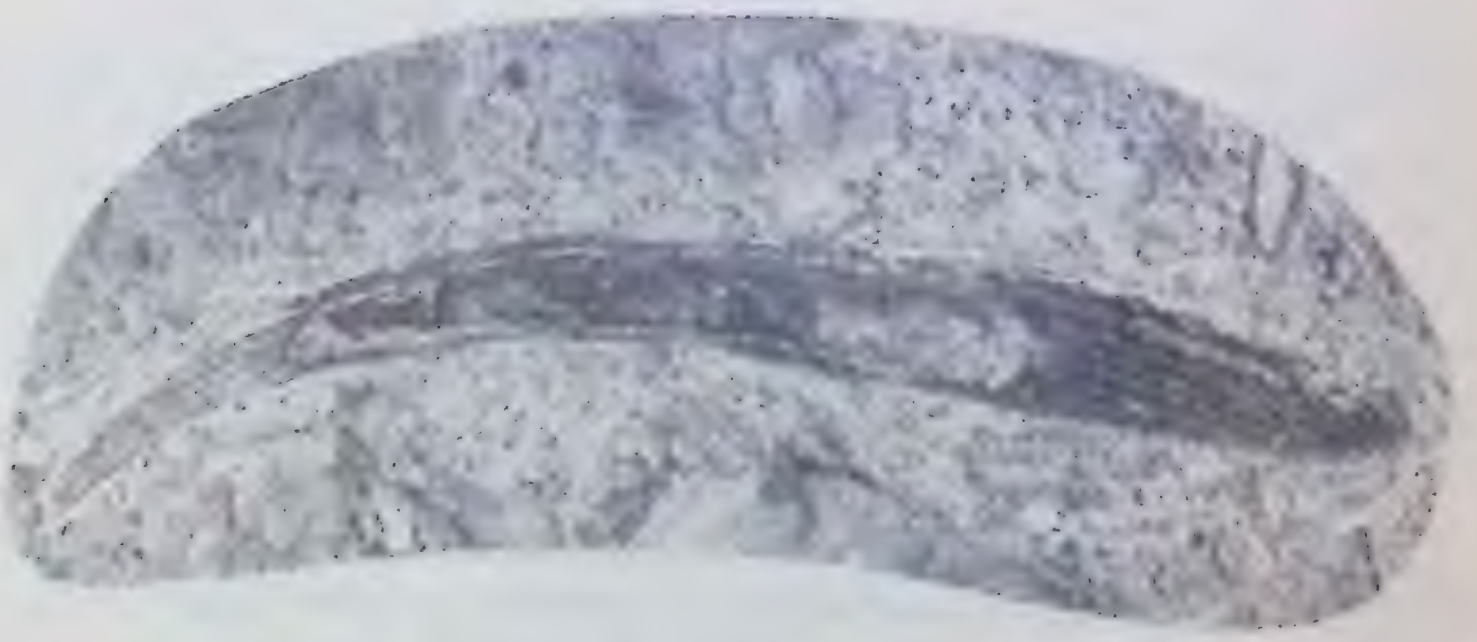

Figure 1. A *Climatius*-like spine from the Stonehouse Formation, Arisaig Series (Silurian), of Nova Scotia (NMC No. 10011). Length of specimen is 7.5 cm.

Four ribs run behind these, narrow and unrelieved. There are no posterior denticles.

Unless the specimen has been more severely abraded than is apparent, the zone of insertion at the base is very shallow, reaching barely .3 cm at the anterior edge and diminishing slightly behind.

The maximum length of the spine is 7.5 cm, and the maximum breadth .7 cm. Median thickness was about .3 cm.

## DISCUSSION

Essentially similar to *Climatius* are the other acanthodian spines *Euthacanthus* and *Parexus*, both Devonian and proportionally longer than the broad-based, often almost triangular spines referred to *Climatius*. All three genera bear small denticles on the hind edge of the spines.

The size of the present specimen is not unusual in species grouped under the name "*Climatius*," though the actual dimensions rather suggest *Parexus* or *Euthacanthus*. *Homacanthus* has much the same proportions as the present specimen but is very much smaller, and the details of ornamentation are different. For the moment it is perhaps prudent to refer the spine to the taxonomically rather broad and better known genus *Climatius*.

The interest attaching to this specimen is in its low stratigraphical horizon and in its association with marine invertebrates. Denison (1956, p. 424) points out that all Silurian Acanthodii are so far known only as fragments – spines, teeth, scales – and are restricted to marine deposits. Devonian acanthodians of the *Climatius* type appear in both marine and non-marine formations. Three small acanthodian spines, tentatively identified in the field as *Onchus* sp., were found in the "Red Stratum," lower in the Silurian succession, during the present search. The palaeogeographical and environmental significance of this remarkable red-bed member of the Arisaig Series is to be discussed by the writer elsewhere, but it may be said here that in the "Red Stratum" is evidence that the acanthodians had already moved into the non-marine environment. This does not mean that they were not to be found in marine waters; possibly they lived in fresh and marine waters alike. While the present specimen is associated with marine shells, it is well to remark that these are certainly current-drifted and that the spine is the lone representative of its class in this bed. It may have well come from a different though not very distant habitat.

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# Natural History Papers

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DEPARTMENT OF NORTHERN AFFAIRS
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OTTAWA

NUMBER 17 AUGUST 27 1962


# FISH REMAINS FROM ONTARIO INDIAN SITES 700 TO 2500 YEARS OLD


D.E. McALLISTER


The fish remains from archaeological sites provide dated evidence on the distribution of fishes in prehistoric times, as well as information on the diet of the Indians. The fish remains discussed in this paper were discovered during the investigations of J.V. Wright of the National Museum of Canada. Forthcoming bulletins of the National Museum of Canada will discuss the archaeology of the sites. Presumably the remains were from fishes caught by the Indians for food. Only one fragment appeared to be burnt. Fig. 1 shows fish bones from the oldest site, the Donaldson. The fishes are considered under the site at which they were found. Some general comments are then made.

## Donaldson Site

This site is on the north bank of the Saugeen River, three miles from its mouth on Lake Huron, Bruce County. The bones were obtained in May to June of 1960 from undisturbed midden deposits or pits of the early Middle Woodland Period. The find of a net sinker and a socketed bone harpoon suggests some of the fishing methods employed. The river at the site is presently 60 to 100 feet wide. Fish may have been caught here or perhaps in the lake. All the species are known to inhabit rivers. They may have been caught in traps during spring spawning runs, as most are spring spawners. The species are all found in this area at present. A carbon dating by the University of Saskatchewan places the site at 2480 years

plus or minus 60 years. The fish are catalogued under NMC62-114-S of the fish collection of the National Museum of Canada.

## ACIPENSERIDAE

*Acipenser fulvescens* Rafinesque — lake sturgeon

The lake sturgeon was represented mainly from plates of the skull or lateral scutes. A parasphenoid and several fulcra were also present. Sturgeon bones were the most common in the deposit (see fig. 1A and 1B).

## CATOSTOMIDAE

*Catostomus commersonii* (Lacépède) — white sucker

The white sucker was represented by pharyngeal teeth and scales. These and other scales were identified using the key in Lagler (1947) (see fig. 1C). Other catostomid remains, including maxillaries, opercula, cleithra, Webberian apparatus, may also represent this species.

## ICTALURIDAE

*Ictalurus punctatus* (Rafinesque) — channel catfish

The channel catfish was represented by articulars, dentaries, a portion of the cleithrum, a dorsal spine, and pectoral spines (see fig. 1D).

## CENTRARCHIDAE

*Micropterus* sp. — black bass

Two maxillaries of black bass were found at the site.

## SCIAENIDAE

*Aplodinotus grunniens* Rafinesque — freshwater drum

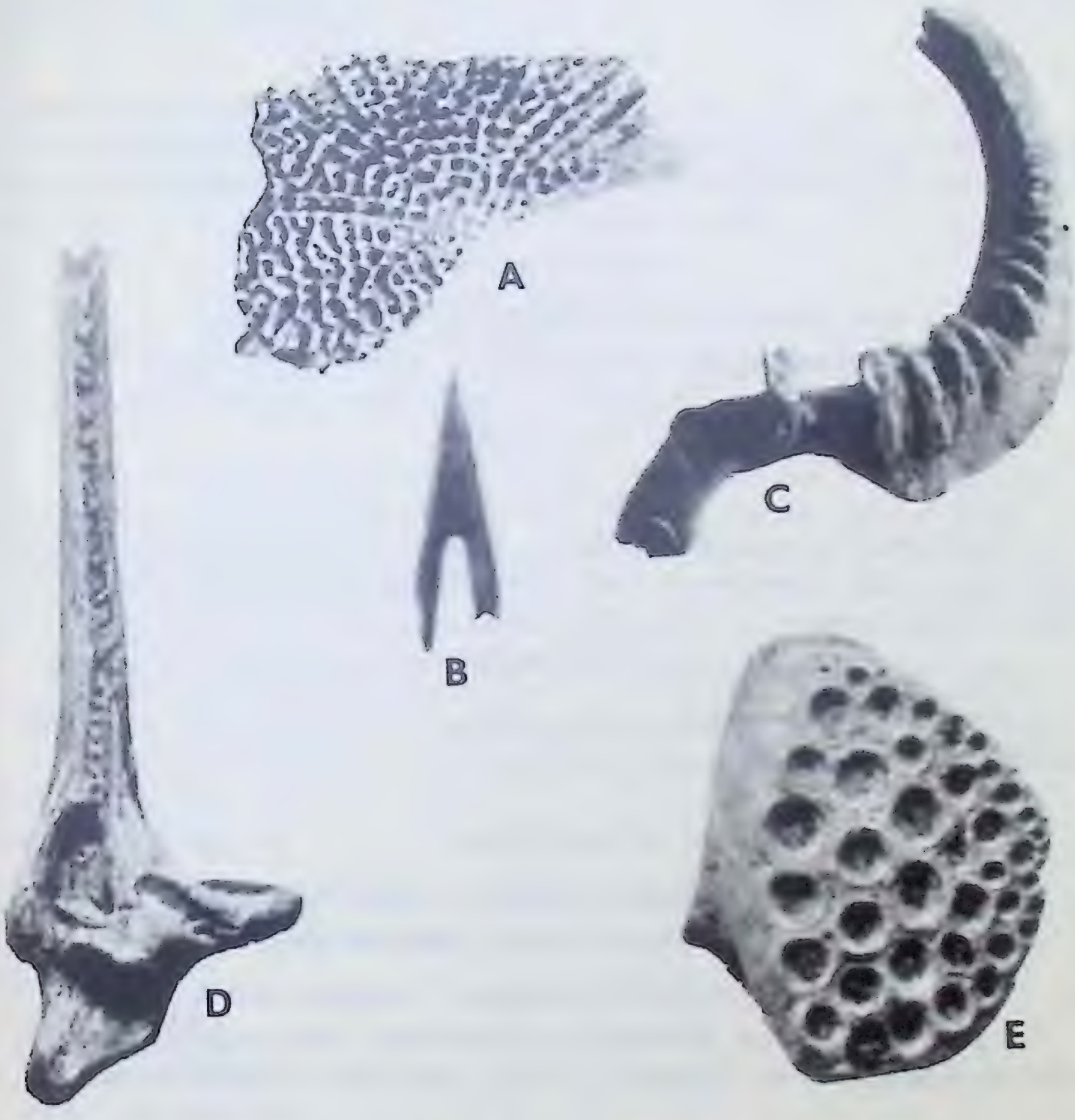
The freshwater drum was represented by its characteristic pharyngeal teeth, its premaxilla, anal spines, dentaries, and a scale. Calculating the size of fish from the largest anal spine in the collection resulted in a standard length of 21 inches (see fig. 1E).

## PERCIDAE

*Perca flavescens* (Mitchill) — yellow perch

The yellow perch was represented by only two scales.

*Stizostedion* sp. — walleye or sauger




Fish remains from Ontario Indian sites 1000-2500 years old.

Fig. 1. Bones from the 2500-year-old Donaldson site. *A.* scute of lake sturgeon, *Acipenser fulvescens*; *B.* fulcra of lake sturgeon; *C.* pharyngeal arch of white sucker, *Catostomus commersonii*; *D.* pectoral spine of channel catfish, *Ictalurus punctatus*, and *E.* pharyngeal bone of freshwater drum, *Aplodinotus grunniens*.

Bones of *Stizostedion* represented in the collection were dentaries, vomers, premaxilla, and palatines.

### Goessens Site

The Goessens site is in Norfolk County near Glen Meyer on a small creek, approximately ten miles from Lake Erie. The estimated date of the site is about A.D. 1200. The fishes are catalogued under NMC62-113-S.

## ACIPENSERIDAE

*Acipenser fulvescens* Rafinesque – lake sturgeon

Represented only by one head plate.

## ESOCIDAE

*Esox* sp. – pike

A 56-mm-long maxillary belongs either to the northern pike, *Esox lucius*, or to the muskellunge, *Esox masquinongy*. From the locality of the site one would judge it to be a northern pike.

## CATOSTOMIDAE

Several preopercula and a subopercular of a sucker are not further identifiable with our osteological collections.

## ICTALURIDAE

*Ictalurus nebulosus* (LeSueur) – brown bullhead

A hyomandibular and a pectoral spine were referable to this species.

*Ictalurus punctatus* (Rafinesque) – channel catfish

Two articulars were referable to this species. Also probably referable were cleithral fragments, a basihyal, dorsal spine, and a dorsal basal.

## SCIAENIDAE

*Aplodinotus grunniens* Rafinesque – freshwater drum

A hyomandibular and a dentary bone were referable to this species.

## PERCIDAE

*Perca flavescens* (Mitchill) – yellow perch

The yellow perch is clearly represented by two of its serrated preopercula.

*Stizostedion* sp. – walleye or sauger

*Stizostedion* remains included preopercula, dentaries, a subopercular, opercula, and a cleithrum.

### Stafford Site

The Stafford site is in Elgin County in Malahide Township. The date of the site is estimated at A. D. 1150. Only a single identifiable fish bone was found at the site. It is catalogued as NMC62-112-S.

## ICTALURIDAE

*Ictalurus punctatus* (Rafinesque) – channel catfish

A 53-mm fragment of an articular bone represents the channel catfish.

The following table compares the fish remains found at three different Ontario sites. The data from the Prescott site are from McAllister (1961). A plus indicates the presence, a minus the absence of a species from the site. If a species is included in parentheses after the family, it means that the family was represented only by that species.

TABLE 1. *A comparison of fishes at different Ontario archaeological sites*

| Family and Species | Prescott site 600 years old | Goessens and Stafford sites 700 years old | Donaldson site 2,500 years old |
|---|---|---|---|
| ACIPENSERIDAE *(Acipenser fulvescens)* | – | + | + |
| LEPISOSTEIDAE *(Lepisosteus osseus?)* | + | – | – |
| ESOCIDAE | + | + | – |
| *(Esox lucius)* | + | – | – |
| CATOSTOMIDAE | + | + | + |
| *Catostomus catostomus* | + | – | – |
| *Catostomus commersonii* | + | – | + |
| *Ictiobus* and *Carpioides* | + | – | – |
| ICTALURIDAE | | | |
| *Ictalurus punctatus* | – | + | + |
| *Ictalurus nebulosus* | – | + | – |
| CENTRARCHIDAE *(Micropterus)* | – | – | + |
| SCIAENIDAE *(Aplodinotus grunniens)* | – | + | + |
| PERCIDAE | + | + | + |
| *Perca flavescens* | + | + | + |
| *Stizostedion* | + | + | + |
| Total number of forms | 8 | 8 | 7 |
| Grand total of forms for all sites .....13 | | | |

One could not conclude from the table that there were major diet differences between the sites in terms of preferences for particular fish species. Such differences as there are between sites might be explained by local absence of the species or by failure of the remains to be preserved at the site.

With regard to the faunal composition, the forms represented are all found in the general area today, except for *Ictiobus*. *Ictiobus* is not presently found so far north. Generally speaking, the fishes are mainly warmwater types which have reinvaded this area from the south The absence of the gar from the two older sites is interesting. Its characteristic scales are readily preserved and would probably have been found at the sites if it had been eaten there. On the basis of the present distribution of the longnose gar, one would judge that it has only recently gained the St. Lawrence River. The absence of it from 700- and 2500-year-old sites suggests that it may not then have penetrated that far north.

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OTTAWA, 1962

Cat. No. R95-5/17

QL 1 C21 APR 3 1963


# Natural History Papers

## National Museum of Canada

DEPARTMENT OF NORTHERN AFFAIRS
AND NATIONAL RESOURCES

OTTAWA

NUMBER 18 APRIL 3 1963


## NEW FRESH-WATER AMPHIPOD CRUSTACEANS FROM FLORIDA

E. L. Bousfield

The freshwater amphipod fauna of Florida has not been intensively studied, and previous records are confined to a very few publications. Only five species have been authentically recorded from the state, viz., *Hyalella azteca* Saussure (Weckel, 1907; Hubricht, 1943), *Orchestia uhleri* Shoem. (Hubricht, 1943), *Crangonyx hobbsi* Shoem. (Shoemaker, 1941; Hubricht, 1943), *C. serratus* Embody (Hubricht, 1943), and *Gammarus triginus* Sexton (Bousfield, 1958). Records of *Gammarus fasciatus* Say in Weckel (1907) and Hubricht (1943) are not confirmed; they may be referable to the similar species, *G. tigrinus* Sexton, which is known from some of the same localities. The material of "*Crangonyx gracilis gracilis*" (Hubricht, 1943) from Alachua, Seminole, Leon, and Jackson counties, in Florida, probably consists of at least two species, none referable to Smith's original Great Lakes' species, and the smallest of which may be conspecific with a form herein newly described. Six other species recorded by Hubricht (1943) from Alabama, Georgia, South Carolina, and neighbouring states may be expected in northern Florida. These include *Gammarus minus* Say 1818 (springs and cave streams), *Crangonyx richmondensis richmondensis* Ellis 1940 (ponds and ditches), *Synurella chamberlaini* Ellis 1941 (temporary ponds, swamps), *Synurella bifurca* Hay 1882 (springs and sloughs), *Stygobromus smithi* Hubricht 1943 (seeps and wells), and *Synpleonia alabamensis* Stout 1911 (wells). Certain brackish-water and estuarine amphipods (e.g. *Corophium, Grandidierella*) might also be expected in the lower stretches of

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large rivers of Florida, in company with *Gammarus tigrinus*, *Callinectes sapidus*, and other euryhaline animals. The present account treats four species, two of which (*Crangonyx floridanus* and *C. grandimanus*) are newly described.

The author is grateful to Mr. R.D. Warren, Florida Speleological Society, Gainesville, who supplied critical material for this study and who invited the writer to participate in a most profitable and enjoyable collecting trip to sinks and caves in the Gainesville region.

## MATERIAL EXAMINED

### Family GAMMARIDAE

**1. Crangonyx floridanus n. sp.**

syn: *Crangonyx gracilis gracilis* Hubricht (1943), p. 691 (small form)?

Highlands Hammock State Park, Highlands Co., shallows at edge of cypress swamp, under organic debris, E.L.B. coll., Jan. 22, 1962; female (type), male (allotype), NMC 5004; paratype female, paratype male, NMC 5005. Gerard's Cave, 5 miles northwest of Marianna, Jackson Co., on floating log in small pool, A.E. Smalley coll., Oct. 20, 1960; female, male (paratypes), NMC 5006; 17 ovig. females, 9 immature females, NMC 5007.

*Diagnosis* (fig. 1,2). A small species of the *pseudogracilis* group having small, slender, weakly armed gnathopods with singly inserted superior lateral setae, with acutely produced posterior angles of the abdominal side plates, and with the outer ramus of uropod 2 (in the male) armed with comb spines; distinguished by the strongly mucronate abdominal side plate 1, by the small (sometimes weakly pigmented) eye, and by the very weak armature of the palmar margins of gnathopods 1 and 2 in the female.

*Female* (5.0-6.5 mm). Eye small, ovate, black, well pigmented in epigean material. Antenna 1, peduncular segments 1 and 2 subequal, 3rd much shorter; flagellum of 20 to 24 segments; accessory flagellum slightly longer than 1st flagellar segment. Antenna 2, peduncular segments 4 and 5 subequal, slender, moderately setose, posterior margins each with about three groups of setae; flagellum of seven to eight segments.

Mandibular palp slender, outer margin of terminal segment with one proximal seta; lacinia mobilis bi- or tri-cuspate. Maxilla 1, inner plater with five marginal plumose setae; palp longer than outer plate. Maxilla 2, plates subequal in length, inner plate broadest in middle, with oblique facial row of six to seven plumose setae. Maxilliped, inner plate very short, subtruncate, with three marginal plumose setae and four apical spine teeth, one of which is slender; palp strong, segment 2 distally broad.

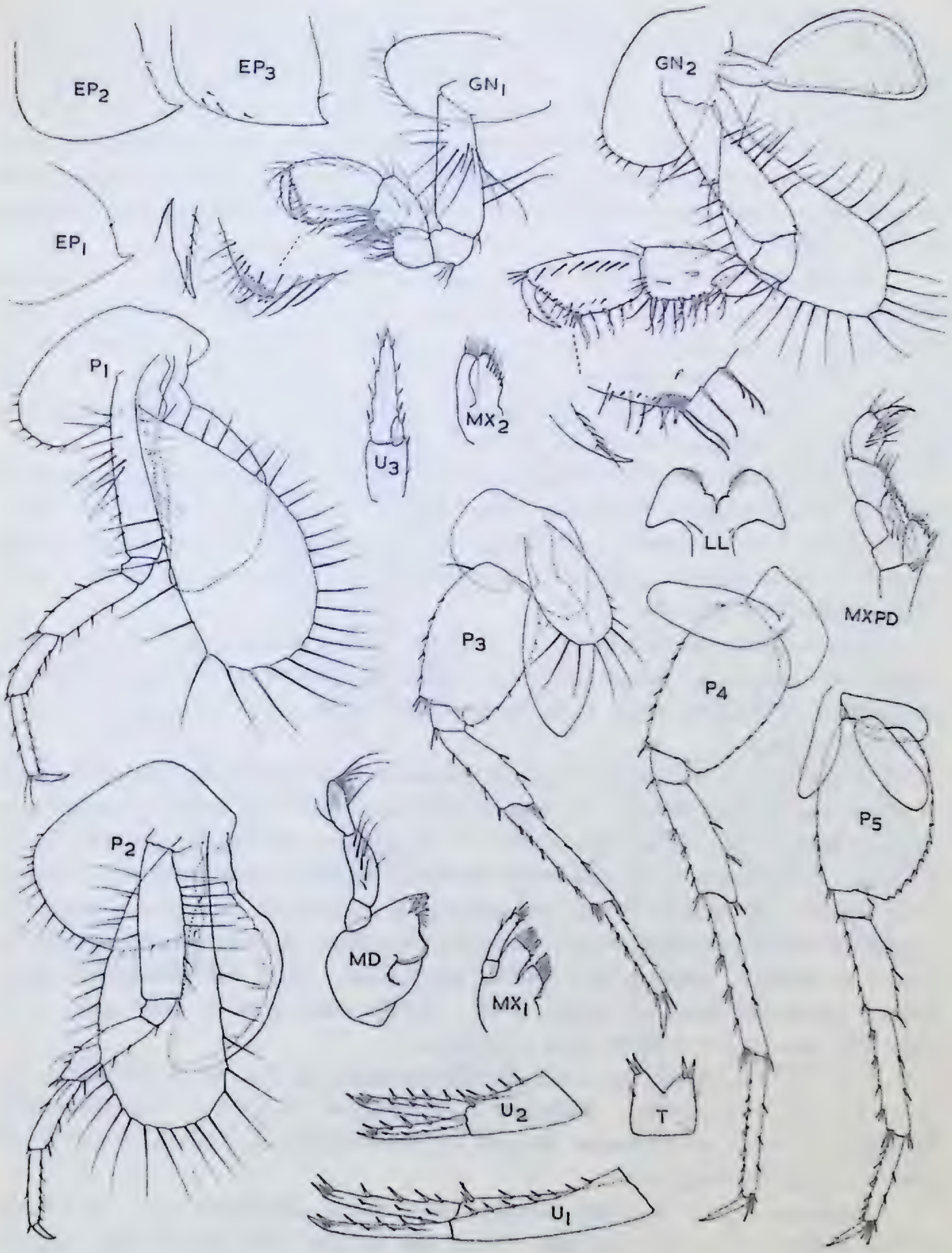


Fig. 1. *Crangonyx floridanus* n. sp. Highlands Hammock State Park, Highlands Co., Florida. Female, 5.0 mm (TYPE)

Coxal plate 1, lower margin with about eight short setae. Gnathopod 1, propodus subquadrate, palmar margin nearly straight and almost perpendicular to lower margin, lined with well-spaced and very weak spines and slender setae; posterior angle smoothly rounding, with one large and two small spines on the outer side and five small spines on the inner; posterior margin with about five singly inserted slender setae; dactyl strong, inner margin with a few weak setae; nail long, tip closing among spines at palmar angle.

Gnathopod 2 larger than 1, carpus and propodus subequal in length; propodus subrectangular, palmar margin slightly convex, oblique, lined with weak spines and slender setae; posterior angle with three medium spines on outer side and one large and two small spines on the inner; posterior margin with four to five groups of long pectinate setae; inner face with seven to eight superior lateral setae, singly inserted.

Peraeopod 2, coxal plate subquadrate, postero-ventral margin smoothly rounding, lined with up to twenty slender setae; segment 2 relatively short. Peraeopods 3 to 5 slender, 4th longest, posterior margin of basos weakly serrate in 3, sharply serrate in 5; dactyls (in all) about one-third the length of the respective propods.

Coxal gills moderately large, present on segments 2 to 6. Sternal gills lanceolate, paired on segment 6, two pairs on segment 7. Brood plates on segments 2 to 4 rather large with long setae; brood plate on segment 5 short, with few setae.

Abdominal side plates 1 to 3, posteroventral angles acute, those of 1 and 2 acutely produced. Pleopods similar, well developed, inner ramus slightly longer than outer and about 1½ times the peduncle. Uropod 1, rami subequal and shorter than peduncle which is armed posteriorly with several stout spines. Uropod 2, rami and peduncle subequal, spinose posteriorly. Uropod 3, outer ramus slender, tapering distally, lateral margins with four groups of spines; inner ramus short, scale-like, with one subapical spine. Telson about as long as wide, cleft widely one-third to the base, lobes each with two to three stout apical spines.

*Male* (3.4-4.5 mm). Eyes slightly larger than in female. Antenna 1, flagellum of twelve segments. Antenna 2, flagellum of four to five segments; elongate calceoli on anterior margin of peduncular segments 4 and 5 and first two flagellar segments.

Gnathopod 1 relatively stouter and more powerful than in female; palmar margin smoothly convex, lined on either side by strong cleft-tip spines; tip of dactyl closing among spines at posterior angle. Gnathopod 2, propodus distally widest, palmar margin oblique, smoothly convex; spines numerous, largest at posterior angle; about five superior lateral setae, singly inserted.

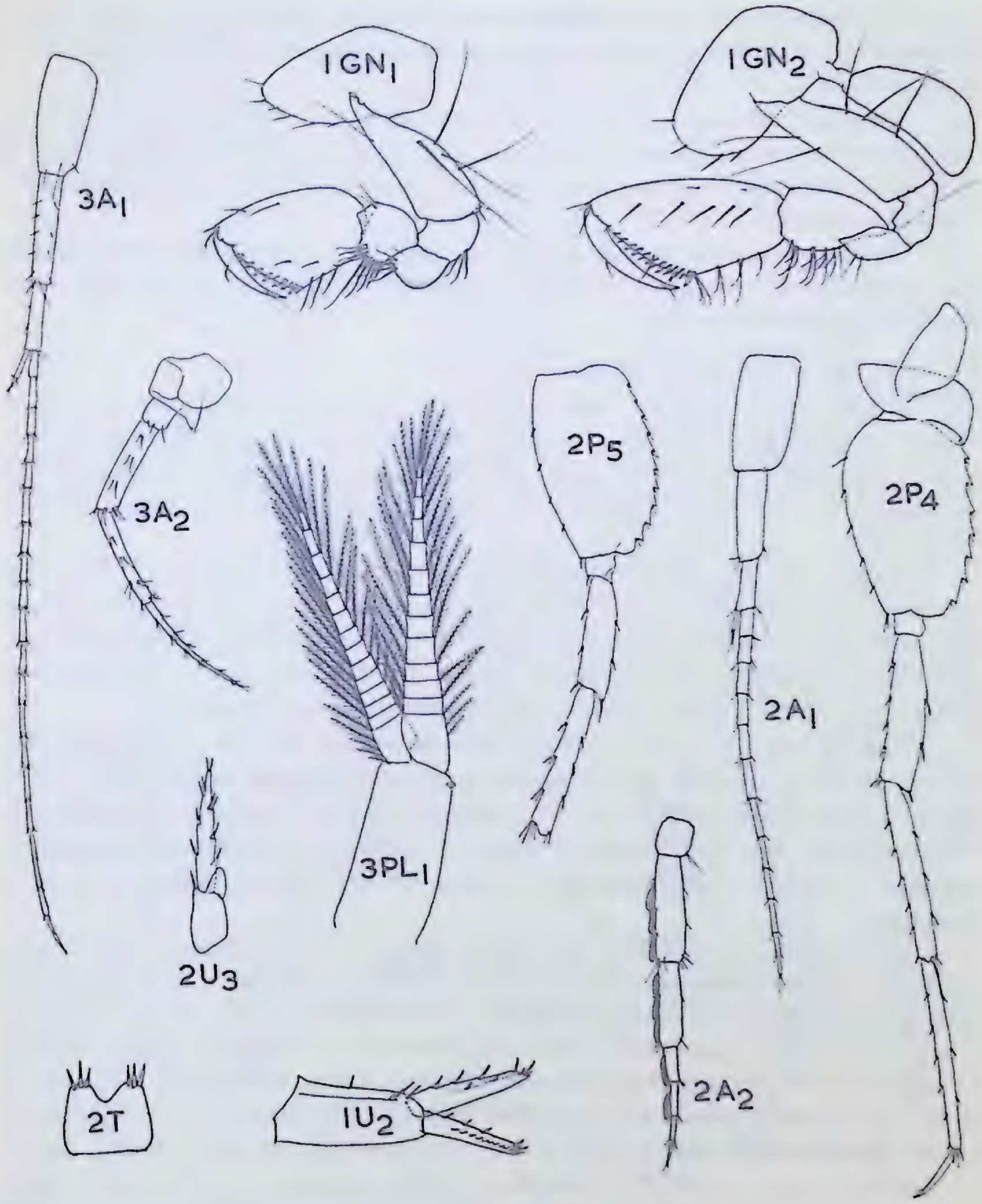


Fig. 2. *Crangonyx floridanus* n. sp. Highlands Hammock State Park, Highlands Co., Florida. (1). Male, 3.5 mm (ALLOTYPE)
Gerard's Cave, Jackson Co., Florida. (2). Male, 4.0 mm (PARATYPE) (3). Female, 6.0 mm (PARATYPE)

Peraeopods relatively slender and elongate; length of dactyls about one-third the propods; posterior margin of basos sharply serrated, especially on peraeopod 5.

Uropod 2, rami shorter than peduncle; outer ramus slightly shorter than inner, bearing row of fine comb-spines distally along outer margin. Uropod 3, outer ramus very slender; inner ramus unarmed. Telson shallowly cleft, apices tri-spinose.

*Remarks.* Material from Gerard's Cave differs somewhat from the cypress swamp specimens in having weakly pigmented eyes (6 - 12 facets only) and in minor points of setation.

**2. Crangonyx grandimanus n. sp.**

Indian Cave, 7 miles southwest of Ocala, Marion Co., in pool, R.D. Warren coll., Feb. 18, 1961; one larviparous female (type), NMC 5002. Huggins' Cave, west of Gainesville, Alachua Co., in pools, associated with C. *Hobbsi* Shoem., R.D. Warren coll., Dec. 17, 1961, one ovigerous female, NMC 5003.

*Diagnosis* (fig. 3). A moderately large, blind species of the *richmondensis* group having reduced mouth-parts and long, slender peraeopods with weakly serrated bases; distinguished by very large gnathopods, conspicuously armed at the posterior angles by the distally expanded coxal plate 1 and by the slender, heavily armed peraeopods and uropods.

*Female* (15 mm). Eyes lacking. Interantennal lobe of head prominent, sharply rounding. Antenna 1, peduncular segment 2 longest, 3rd shortest; flagellum of about thirty segments; accessory flagellum minutely 2-segmented, slightly longer than first flagellar segment. Antenna 2, peduncular segments subequal, surfaces with numerous clusters of stiff setae; flagellum of nine segments.

Mouth-parts remarkably similar to those of C. *richmondensis* Ellis. Mandible, molar process rather weak, grinding surface relatively small; incisor and lacinia mobilis prominent, multi-cuspate; palp large, segments 2 and 3 subequal, segment 3 with only three outer marginal setae. Maxilla 1, inner plate with only two marginal plumose setae. Maxilla 2, inner plate short and broad, facial row of setae lacking. Maxilliped, inner and outer plates small, weakly spinose; palp large and powerful, segment 2 very broad.

Coxal plate 1 broadest distally, corners each with four to five short setae. Gnathopod 1, propodus large and powerful, palm oblique, smoothly convex, margin lined on either side with about thirty regularly spaced slender spine-teeth; posterior angle defined by three prominent spines, among which the tip of the smoothly curving dactyl closes; posterior margin lined with eight singly inserted setae.

Coxal plate 2 narrowing distally, lower margin with about eight setae. Gnathopod 2, propodus very large and powerful, subovate; palm oblique,

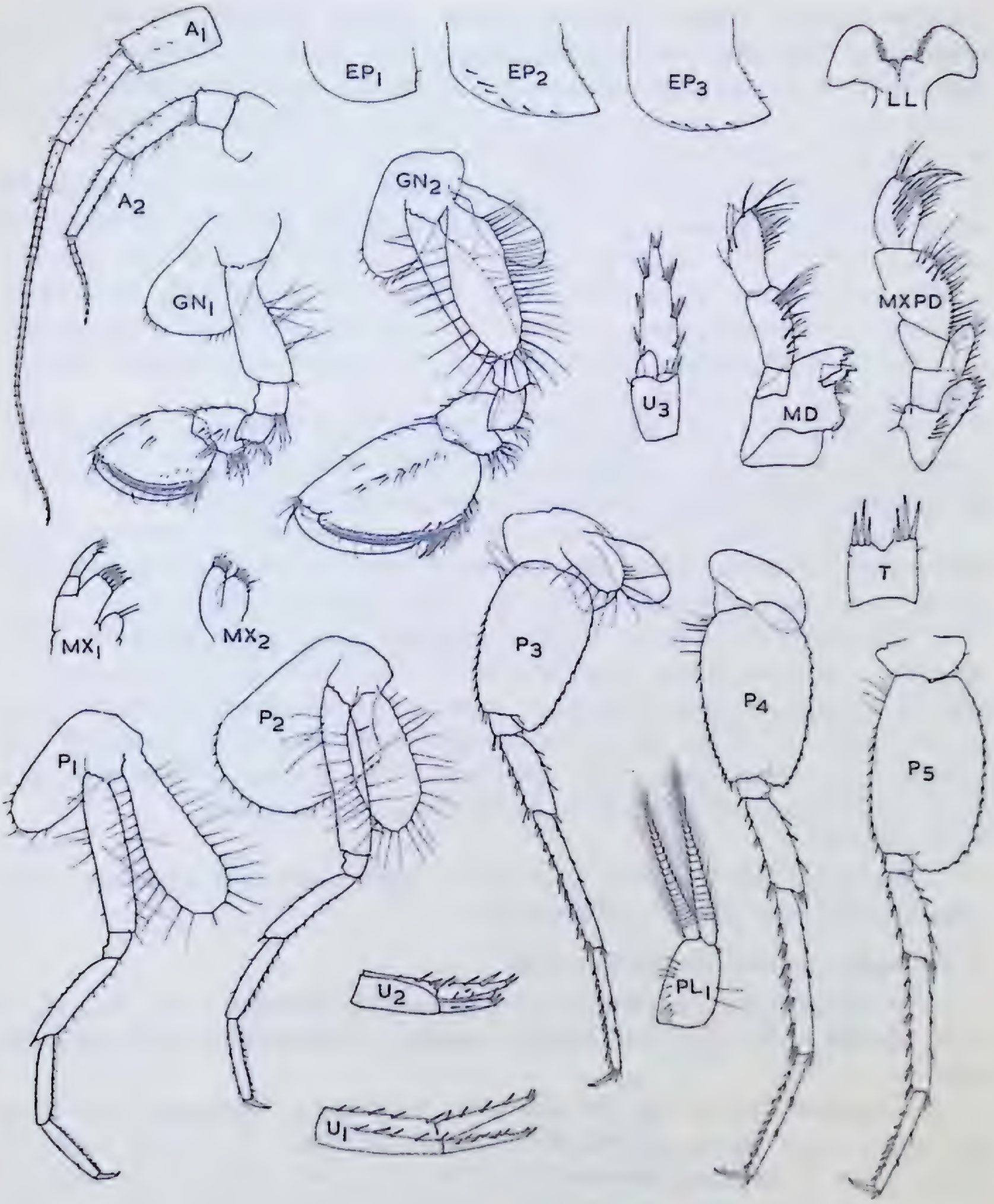


Fig. 3. *Crangonyx grandimanus* n. sp. Indian Cave, Marion Co., Florida. Female, 15.0 mm (TYPE).

smoothly convex, margin lined on either side by more than thirty evenly spaced teeth; posterior margin with four to five clusters of setae; posterior angle defined by four or five long heavy spines directed anteriorly; superior lateral setae in six groups, most doubly inserted. Posterior margin of propodus very short, bearing four groups of setae.

Peraeopod 1, coxal plate narrowing distally; segments long and slender; segments 5 and 6 lined posteriorly with numerous clusters of short stiff spines. Peraeopod 2 slightly smaller than 1 but segments are similarly slender and spinose; coxal plate broad. Peraeopods 3 to 5 long and slender, 4th longest; anterior margins of segments 4 to 6 in each armed with numerous clusters of stout spines. Basos of each peraeopod large, ovate, posterior margin serrate, most sharply in peraeopod 5.

Coxal gills small, present on segments 2 to 6. Sternal gills slender, lanceolate, paired on segment 6, two pairs on segment 7. Brood plates rather small, especially on segment 5; brood setae numerous.

Abdominal side plates 2 and 3 with prominent, acute posterior angles; lower margins armed with a few spines. Pleopods moderately strong; inner ramus longer than outer and double the length of the stout peduncle.

Uropods 1 and 2 stout, margins spinose; inner ramus somewhat longer than the outer and rather broad proximally, that of uropod 1 with only one row of marginal spines. Uropod 3, outer ramus relatively short and broad, about double the peduncle; lateral margins each with three groups of stout spines; inner ramus short, with subapical spine. Telson subquadrate, shallowly cleft; lobes each with three to four long apical spines.
Male unknown.

*Remarks.* The form and armature of gnathopods and peraeopods indicate a carnivorous habit in this species.

**3. Crangonyx hobbsi** Shoemaker 1941

Huggins' Cave, northwest of Gainesville, Alachua Co., E.L.B. and R.D. Warren coll., Jan. 14, 1962, 7 males, 11 females (topotypes), NMC 5001.

*Remarks.* Two of the females were ovigerous, indicating that breeding takes place during the winter at least. In uropod 2 of both sexes, the inner ramus is broadest proximally. In the male, the outer ramus of uropod 2 is armed on the outer margin with seven to eight evenly spaced spines, whereas in the female the spines are stouter but fewer (5-6). The pleopods are well developed, with stout peduncle and inner ramus distinctly longer than the outer.

## Family TALITRIDAE

**4. Hyalella azteca** Saussure

Matthew's Sinks, 7 miles east of Bronson, Levy Co., R.D. Warren coll., Nov. 18, 1961, three very immature specimens, NMC 5008. Hillsboro Canal, at Highway 441, Broward Co., weedy margins, E.L.B. coll., Jan. 21, 1962, five males, three ovig. females.

*Remarks.* The mid-dorsal mucronation of abdominal segments 1 and 2 are pronounced in Florida material. Although the species is widely distributed ecologically and geographically, its occurrence in a sink is unusual.

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OTTAWA, 1963

Cat. No. R95–5/18

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Natural History Papers

National Museum of Canada

DEPARTMENT OF NORTHERN AFFAIRS
AND NATIONAL RESOURCES

OTTAWA

30 SEPTEMBER,

NUMBER 19 1963

# ADDITIONAL RECORDS OF MASTODONS AND MAMMOTHS IN CANADA

C. M. STERNBERG

In 1930 I published an article on "New Records of Mastodons and Mammoths in Canada" (7). Since that time new discoveries and records that were missed have come to light. It is the idea of this article to bring the list up to date and to include only quaternary finds. As in the earlier article, I shall not list specimens from Yukon Territory or, of course, those reported at that time; but in order to have the list as complete as possible, I will include some mentioned in isolated reports (1), (2), (3), and (5).

All of the mastodons are regarded as belonging to *Mammut americanus*, and all but three of the mammoths to *Mammuthus primigenius*. These three have been identified as *Mammuthus columbi* and are listed at the beginning of the mammoth listing.

Most of the mammoths were found in glacial or interglacial gravel or sand. Some of the mastodons were found in gravel or sand, but most of those found in Ontario were discovered in muck or dark clay. Some were plowed up in low land, and several were found by farmers while digging ditches to drain swampy land. There is very little evidence of the bones having been washed into the swamps, but in most cases it would appear that the animal bogged down in the muck or soft clay when searching for food. If the skull and skeleton are located, it would suggest that the soft muck was at least three feet deep; otherwise, the skull would not have been completely buried and that part exposed would have been destroyed. All this would

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suggest that mastodons inhabited southwestern Ontario until quite recently and it is not surprising that radiocarbon dating has shown this to be so.

Professor A. Dreimanis of the University of Western Ontario, London, presented a paper at the 1961 meeting of the G.S.A., showing that the radiocarbon dating of the gyttja found in the cavities of the skull of the Tupperville mastodon showed it to be 6230 ± 240 years B.P. (1)(4,p.73). The mastodon could be younger than the material in which it was buried but could not be older. In a study of mastodons and mammoths of Michigan, Miss Skeels (6, p.112) lists a mastodon that shows a radiocarbon dating of 5950 ± 300 B.P.

Dr. L.S. Russell reported on a partial skeleton of mastodon, collected by the Royal Ontario Museum, from near Rodney, Ontario (5). This specimen occurred in a black vegetable muck, 2 to 3 feet thick, resting unconformably on sand and gravel. He traced the sand and gravel into a Lake Whittlesey beach deposit. Geological evidence thus indicates a post-Whittlesey age for the bones. The bones occurred at or near the base of the muck, often resting upon the sand but never included in it. This suggests that the muck must have been near its present thickness when the mastodon bogged down in it, and that the material at the base of the bog must be older than that at the top. A sample of wood and black muck from the base of this bog was dated by McCallum and Dyck (4, p.74) as 11000 to 12000 years B.P.

Mastodon records from the Canadian prairies are very rare, and most of the few reported come from areas that are now wooded.

Among the many who have supplied information, I would especially thank Mr. Bruce McCorquodale for his list of 39 Saskatchewan specimens; most of which are preserved in the Saskatchewan Natural History Museum, Regina. I should also like to thank Dr. W.G. Anderson, Medicine Hat, Alta.; Dr. Charles Bell, Chatham, Ont.; T. P. Chamney, Calgary, Alta.; A. Dreimanis, University of Western Ontario, London; A.G. Edmund, Royal Ontario Museum, Toronto; F. H. Edmonds, University of Saskatchewan, Saskatoon; Roy Fowler, Dinosaur Provincial Park, Patricia, Alta.; P. F. Karrow, Ontario Department of Mines, Toronto; E. Leith, University of Manitoba, Winnipeg; Mrs. Don McVeigh, Drumheller Museum, Drumheller, Alta.; L. S. Russell, Director, National Museum of Canada, Ottawa; and C. R. Stelck, University of Alberta, Edmonton.

| Parts discovered | Mode of occurrence and locality | Collector | Reported by | Present location |
|---|---|---|---|---|
| Tusk, 93 in. long..... | Little Bear Creek drain, Chatham Tp., 1887 | Col. E.B. Jones and R.C. Burk | Rept. Dr. C. Bell, Chatham | Kent Co. Museum, Chatham |
| Tusks and much skeleton ..... | Fields Creek drain, Harwick Tp. | Seen by A. Gosnel, 1898 | Do. | Jaw and tooth in Kent Co. Museum |
| Not known..... | McCargon drain, Howard Tp. | – | Do. | Photo in Kent Co. Museum |
| Two tusks ..... | 3 ft. below surface, Henry Arnold farm, Harwick Tp. | – | Do. | Henry Arnold, Troy, Ont. |
| Molar tooth ..... | Plowed up on Frank Craig farm, Howard Tp. | – | Do. | Do. |
| Not ascertained ..... | From McCargon drain No. 2 | – | Do. | – |
| Tooth..... | Postglacial peat bog, w. of Simcoe | Dr. McIntosh, London | A. Dreimanis | University of Western Ontario, London |
| Part of skeleton ..... | Detrital gyttja, 2 mi. sw. Tupperville (1) | A. Dreimanis | Do. | Do. |
| Bones and teeth..... | Calcareous sands, ¼ mi. ne. Tupperville | Do. | Do. | Do. |
| Tooth and bones ..... | 10 ft. below surface in till, ¼ mi. w. Gravesend | – | Do. | Do. |
| Part of skull, etc. ..... | 3 ft. below surface, black muck, 4 mi. e. Ingersoll | – | Do. | Do. |
| Part of tusk..... | Thames valley near Delaware | – | Do. | Do. |
| Lower jaw..... | Lake Whittlesey sand, Caradoc Tp. | H.G. Forbes in 1908 | Do. | Do. |
| Teeth and bones..... | From farm owned in 1900 by E. Mitton | – | A. Dreimanis | No record |
| Part of tusk..... | Mariposa Tp. farm of Marmaduke King | – | A. Dreimanis | Disintegrated |
| Jaw and teeth..... | No information | Donated by O. Johnston | P.F. Karrow | Kent Co. Museum, Chatham |

*Mastodons (Mammut americanus) in Ontario – Cont.*

| Parts discovered | Mode of occurrence and locality | Collector | Reported by | Present location |
|---|---|---|---|---|
| Ribs and limb bones.... | Do. | Donated by O. Johnston | Do. | Do. |
| Teeth ..... | Do. | Donated, N.C. Campbell | Do. | Do. |
| Parts of skull and skeleton..... | From farm of Orvil J. Bond, West Oxford | – | Do. | Oxford Co. Museum, Woodstock |
| Tooth ..... | – | W. Farr | Do. | Do. |
| Tooth and vertebra..... | In swamp near w. Lorne | | Do. | Elgin Co. Museum, St. Thomas |
| Lower jaw ..... | Lot. 8, Con. 3, Romney Tp., farm of Wm. Milne | – | Miss Luise Schryver | Kent Co. Museum, Chatham |
| Skeleton..... | Black muck, overlying Lake Warren deposits ¾ mi. ne. of Wallacetown on farm of Mr. Horkay | A. Horkay | F.A. Bell, St. Thomas | Mr. A. Horkay |
| Part of skeleton ..... | Farm of J. Ferguson, 2 mi. sw. Tupperville | A.G. Edmund | – | Royal Ontario Museum, Toronto |
| Teeth and skeleton .... | Black muck above last glaciation on farm of D. Campbell, 2¾ mi. sw. Rodney (5) | L.S. Russell and L. Sternberg, 1947. Dated as about 11000 years B.P. (6), (7) | | Do. |
| Five teeth ..... | Black muck overlying boulder clay. Lot 21, Con. VII, Garfield N., Essex Co. | C. Jeffery, Ruthven | C.S. Evans | – |
| Teeth and bones..... | Low area in drain ditch on farm of J. McGregor, n. of village of Shadden | M. Tillford, Sr. | G.L. Gray | Elgin Hist. Soc., St. Thomas |
| Part of tusk..... | From near Dresden | – | Prof. M. Baker | Queens University, Kingston |
| Tooth ..... | Near Dresden | Seen in possession of Dr. French | – | Dr. French, Toronto |
| Tusks and part of skeleton..... | Bluish marl, 18 in. below surface, C. Toll farm, Harwick Tp. | R.D. Ussher and G. Edmund | G. Edmund | Rondeau Prov. Park |

*Mastodons (Mammut americanus) in Ontario – Cont.*

| Parts discovered | Mode of occurrence and locality | Collector | Reported by | Present location |
|---|---|---|---|---|
| | | **Mastodons not in Ontario** | | |
| Skull and skeleton..... | Marly black clay, beneath boulder clay, Estate of Mr. Osman near Hillsborough, N.B. | Mr. McIntosh | W.A. Bell | Saint John Museum, Saint John, N.B. |
| Tooth..... | Gravel pit near Pincher Creek, Alta. | Seen by Roy Fowler | – | No record |
| Tooth..... | On gravel bed, Minaker R. 65 mi. n. of Mile 147. Alaska Hwy., B.C. | J.C. Lunan | C.R. Stelck | National Museum of Canada |
| Tooth and fragment of skull ..... | Gravel pit, 14 mi. w. of Cold Lake, Alta. | W.A. Arkenstall | Do. | University of Alberta, Edmonton |
| Tooth fragment ..... | Wapiti River, Alta. | – | Do. | R. Cochrane, Grande Prairie, Alta. |
| Tooth ..... | Burrow pit on north side of Prince Albert | J.N. Campbell | Bruce McCorquodale | Sask. Museum of Natural History |
| Fragment of tooth ..... | Kame gravels at Pilot Butte, Sask. | C. Berg | Do. | Do. |
| Tooth ..... | Post glacial gravels west of Prince Albert | R. Wallace | Do. | Prince Albert Historical Society and Sask. Museum of Natural History |
| Tooth..... | Gravel pit near Jansen, Sask. | – | Do. | University of Saskatchewan, Saskatoon |
| | | **Genus Doubtful** | | |
| Tusk ..... | Gravel 6 ft. below surface Niagara-on-the-Lake, Ont. | Newspaper report | – | Royal Ontario Museum, Toronto |
| Part of tusk ..... | Gravel and till of Southwold drift, 1 mi. sw. Port Talbot | A. Dreimanis | – | University of Western Ontario, London |
| Tooth ..... | Gravel pit near Moosenose, Man. | W.J. Gunne Kenora, Ont. | E. Laith (5) | Some museum in England |

*Mastodons (Mammut americanus) in Ontario – Cont.*

| Parts discovered | Mode of occurrence and locality | Collector | Reported by | Present location |
|---|---|---|---|---|
| | | Genus Doubtful – Conc. | | |
| Femur..... | Not given | Reported by J.W. Dawson, Acadian Geol. P. 84 | – | Provincial Museum, Halifax, N.S. |
| Bones..... | Gravel pit. North of Cochrane, Ont. | Reported by J. Greene, Rouyn, P.Q. | – | – |
| | | Mammoths (*Mammuthus primigenius* and *columbi*) | | |
| Tooth, *M. columbi* .... | From s. of Maple Creek, Sask. | – | G. H. Gilchrist | Maple Creek Museum |
| Tooth, *M. columbi* .... | Matthias Mine, Cariboo Dist., B.C. | – | W.E. Cockfield, Vancouver, B.C. (2) | |
| Tooth, *M. columbi* .... | Cobble Hill, nw. of Mill Bay, n. of Victoria, B.C. | – | News report with photograph | Provincial Museum, Victoria, B.C. |
| Tooth..... | Island in Coronation Bay, N.W.T. | – | C.H.D. Clarke | Washington, D.C. |
| Tooth..... | Pleistocene, near Aklavik, N.W.T. | – | Richard Finnie | – |
| Tusk..... | Ponds Inlet, Bylot Island | – | Constable Dunn, R.C.M.Police | – |
| Tooth and part of tusk.. | Collected by natives e. of mouth of Mackenzie | – | R. Buchard, R.C.M.Police | – |
| Tooth ..... | Coarse gravel, Morehead Mine, Cariboo Dist., B.C. | W.E. Cockfield (2) | – | E.C. Ames, Seattle, Washington |
| Tooth ..... | Pleistocene. Extreme nw. tip of Yukon Territory | Lincoln Washburn | D. Leechman | National Museum of Canada |
| Tooth ..... | Gravel on Sturgeon R., 25 mi. ne. of Edmonton, Alta. | G.H. Turner, Ft. Saskatchewan, Alta. | – | Do. |
| Tooth ..... | Anderson R., N.W.T. | A.F. Kozisch | C.R. Stelck | University of Alberta, Edmonton |
| Part of tusk ..... | 20 ft. below surface, Dodds, Alta. | E.G. Culver | Do. | Do. |

| Parts discovered | Mode of occurrence and locality | Collector | Reported by | Present location |
|---|---|---|---|---|
| Part of tusk ..... | Little Smoky R., 40 mi. s., Valleyview, Alta. | A.A. Steinke | C.R. Stelck | University of Alberta, Edmonton |
| Part of tusk ..... | Gravel pit near Bonnyville, Alta. | – | Do. | Do. |
| Tooth..... | Kinsella, Alta. | D.G. Revell | Do. | Do. |
| Tusk ..... | Medicine Hat, Alta. | F. Connors | Do. | Do. |
| Tooth..... | Glacial till, w. side Red Deer R., w. of Morrin, Alta. | Rev. A.R. Schragg, Drumheller, Alta. | – | – |
| Part of tusk ..... | Gravel pit n. side Red Deer R., Drumheller, Alta. | – | Mrs. McVeigh | Drumheller Museum |
| Tooth..... | No record | – | Do. | Do. |
| Tooth..... | Plowed up on De Boer farm, w. of Drumheller, Alta. | – | Do. | Do. |
| Tooth..... | Rosebud Coulee near Drumheller | – | Do. | Do. |
| Part of tusk ..... | Cambrian Heights, Calgary | T.P. Chamney | – | Calgary Zoo |
| Teeth..... | Gravel pit near Hilda, Alta. | – | T.P. Chamney | Do. |
| Tooth..... | Police Point near Medicine Hat, Alta. | – | W. G. Anderson | Medicine Hat Museum |
| Tooth..... | In glacial kame east of Eastend, Sask. | ? | Bruce McCorquodale | Eastend Museum |
| Tooth..... | Glacial gravels ½ mi. s. of Eastend, Sask. | ? | Do. | Missing, originally in Eastend Museum |
| Two teeth ..... | ? | – | Do. | Old Timers Museum, Maple Creek, Sask. |
| Tooth..... | Surface near Rouleau, Sask. | J. Sutherland | Do. | Mr. Carl Bekkering, Moose Jaw, Sask. |
| Tooth..... | Gravels at Empress, Alta. | – | Do. | Bishop Knowles, Regina, Sask. |

Mammoths (*Mammuthus primigenius* and *columbi*) Cont.

| Parts discovered | Mode of occurrence and locality | Collector | Reported by | Present location |
|---|---|---|---|---|
| Three teeth..... | River terrace gravels, North Battleford, Sask. | V.E. Rae | Bruce McCorquodale | Vaughn E. Rae, North Battleford, Sask. |
| Lower Jaw ..... | In Cutknife Creek s. of Payton, Sask. | J. Tootoosis | Do. | Fort Battleford, Natural History Site Museum |
| Bones ..... | Excavation for highway bridge over Battle Creek at Battleford, Sask. | H. Tatro | Do. | ? |
| Scapula ..... | Glacial gravels near Tugaske, Sask. | N. Hurtig | Do. | N. Hurtig, Central Butte, Sask. |
| Tooth..... | Kame gravels south of Wartime, Sask. | W. Morrison | Do. | W. Morrison, Herschel, Sask. |
| Two teeth ..... | Interglacial gravels near Fort Qu'Appelle | E. Orheim | Do. | E. Orheim, Bengough, Sask. |
| Fragment of pelvis .... | Near Choiceland, Sask. | R. Wallace | Do. | Prince Albert Historical Society Museum |
| Fragment of femur ..... | Gravel pit in Qu'Appelle valley north of Grenfell, Sask. | S. Velestuk | Do. | Saskatchewan Museum of Natural History, Regina |
| Tooth..... | Interglacial gravels at Lake Katepwa | W. Orchard | Do. | Do. |
| Tooth..... | Gravels near Lancer, Sask. | W. Dzioba | Do. | Do. |
| Lower jaw..... | Glacial Kame, Pilot Butte, Sask. | C. Paul | Do. | Do. |
| Three teeth..... | Gravel at Empress, Alta. | — | Do. | Do. |
| Molar ..... | Glacial gravels at Midale, Sask. | P. M. Connelly | Do. | Do. |
| Tooth..... | Gravels near Lancer, Sask. | P. Rayner | Do. | Do. |
| Tooth..... | Gravels in Cut Arm Valley Sec. 20, Tp. 20, R.32. W.1st | R. Debnam | Do. | Do. |
| Tooth..... | Beach of Katepwa L. near Lebret, Sask. | A. Norwig | Do. | Do. |

*Mammoths (Mammuthus primigenius and columbi) Cont.*

| Parts discovered | Mode of occurrence and locality | Collector | Reported by | Present location |
|---|---|---|---|---|
| Two teeth, fragments of scapula and femur ..... | Gravel deposits in Qu'Appelle valley near Crooked L. | – | Bruce McCorquodale | Saskatchewan Museum of Natural History, Regina |
| Tooth..... | Gravel deposits west of Crooked L. | L. Wendell | Do. | Do. |
| Tooth..... | Interglacial gravels at L. Katepwa | J. Fay | Do. | Do. |
| Tusk ..... | In glacial till near Mortlach, Sask. | W. Felt | Do. | Do. |
| Complete tusk ..... | Data lost | Regina College | Do. | Do. |
| Two teeth and several post-cranial elements .. | Interglacial gravels near Fort Qu'Appelle | B. De Vries | Do. | Do. |
| Tooth..... | Gravel pit near Deveron, Sask. | N. Nickell | Do. | Do. |
| Portion of tusk..... | Terrace gravels in Arm River valley near Findlater | D. G. Brock | Do. | Do. |
| Portion of tusk..... | Terrace gravels in Jumping Deer Creek Near Lipton, Sask. | – | Do. | Do. |
| Rib..... | Gravel pit near Kronau, Sask. Sec. 24, Tp.6, R.17, W.2nd | – | Do. | Do. |
| Vertebral spine ..... | Kame gravels at Pilot Butte, Sask. | N. Serbu | Do. | Do. |
| Fragment of tusk ..... | Norman Wells, N.W.T. | A. Sherwood | Do. | Do. |
| Fragment of tusk ..... | Dawson Creek, B.C. | Mr. Rissling | Do. | Do. |
| Fragment of tusk ..... | Sub-till lag deposit near Cadillac, Sask. | W. Baxter | Do. | Do. |
| Tooth fragments..... | Pleistocene drift, 17 mi. nw. Swift Current, Sask. | W. Langston, Ottawa, Ont. | – | National Museum of Canada |
| Teeth..... | Gravel pit, 3 mi. n. of Sutherland Station, Sask. | – | L.S. Russell | University of Saskatchewan, Saskatoon |

Mammoths (*Mammuthus primigenius* and *columbi*) Conc.

| Parts discovered | Mode of occurrence and locality | Collector | Reported by | Present location |
|---|---|---|---|---|
| Tooth ..... | Gravel pit, Nursery Sta., Sutherland, Sask. | – | E.S. Hopkins, Ottawa. | University of Saskatchewan, Saskatoon |
| Tooth ..... | Garden in Qu'Appelle, Sask. | – | F.H. Edmonds, Saskatoon | Do. |
| Tooth ..... | Gravel pit, near Rosenheim, Alta. | – | Do. | Do. |
| Teeth and skeleton .... | ? Post Pleistocene, near Rosetown, Sask. | – | Do. | Do. |
| Teeth and bones..... | Gravel pit, 4 mi. se. of Lebret, Sask. | – | J.L. Fitzpatrick, Lebret, Sask. | No information |
| Tooth ..... | Plowed from black muck, 1½ mi. nw. Arborfield, Sask. | – | Henry Hooton, Arborfield, Sask. | Do. |
| Tooth and atlas ..... | Gravel pit at Ft. Ellis, Sask. | – | L.T.S. Norris-Elys, Winnipeg, Man. | Manitoba Museum, Winnipeg |
| Part of tusk..... | Gravel pit, 4 mi. e. of Transcona, Man. | R. Johnson | E. Leith, Winnipeg (3) | Do. |
| Part of tusk..... | Gravel pit, 3½ mi. n. of Benito, Man. | Alex McKenzie | Do. | Do. |
| Tooth ..... | Gravel pit, 5 mi. e. of Dufresne, Man. | Harry Norman | Do. | Do. |
| Tooth ..... | Esker deposit, Birds Hill, Man. | – | Do. | Do. |
| Tooth ..... | Gravel pit, ½ mi. nw. Eastend, Sask. | H.S. Jones, Eastend, Sask. | – | Eastend School Museum |
| Teeth and tusk ..... | Larkin gravel pit, 2 mi. below Queenston Hgts., Ont. | H. Anderson and J. Parnell | – | Royal Ontario Museum, Toronto |
| Part of tusk..... | Gravel pit of J. Cook and Sons, Aldershot, Ont. | – | P.F. Karrow, Toronto | J. Brant Museum, Burlington |

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OTTAWA, 1963

Cat. No. R95-5/19

OCT 1 1963

Natural History Papers

National Museum of Canada

DEPARTMENT OF NORTHERN AFFAIRS
AND NATIONAL RESOURCES

OTTAWA

NUMBER 20

30 SEPTEMBER, 1963

# STUDIES OF THE BYRON BOG IN SOUTHWESTERN ONTARIO XVI. OBSERVATIONS ON THE LIFE CYCLES OF TWO SPECIES OF *CRANGONYX* (CRUSTACEA: AMPHIPODA)

W.W. JUDD *

During 1961 and 1962 studies were undertaken on the non-insect invertebrates of the Byron Bog at London, Ontario, as part of a programme of studies sponsored by the National Museum of Canada. The Byron Bog and its vegetation zones have been described by Judd (1957).

In 1961 regular daily collections of invertebrates were made from May 8 to September 29 in the four different regions of the bog (Judd, 1957). These four regions were wooded slopes (c), lower wooded region (b), open floating bog (a) and the open pond, Redmond's Pond (D) (Fig. 1). In regions a, b, and c, plots were marked out with stakes, each plot 250 feet by 50 feet in size. Each plot, in turn, was divided into five smaller sub-plots of dimensions 50 feet by 50 feet, numbered from 1 to 5 (Fig. 1). Starting on May 8, collections were made in the sub-plots numbered "1" in regions a, b, and c. The next day collections were made in sub-plots numbered "2." This procedure was followed, in sequence, on successive days in plots numbered "3," "4," and "5." The procedure was repeated through the summer. This procedure prevented repeated disturbance each day of the population of creatures in any one sub-plot. Collections in region D, Redmond's Pond, were made daily by making three sweeps about three yards long through the water with a dip-net having a mouth 10 inches in diameter. Aquatic animals were collected with the dip-net in pools that were present in spring in regions a, b, and c. Among the invertebrates so collected were the two scuds, *Crangonyx rivularis* Bousfield and *Crangonyx*

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*richmondensis laurentianus* Bousfield. They were identified by use of keys in Bousfield (1958) and confirmed by that author.

In 1962 a study of the life cycle of *C. richmondensis laurentianus* was undertaken by making regular collections in Redmond's Pond from April 17, soon after the ice had disappeared permanently from the pond, until December 1st when half an inch of ice formed over the surface of the pond. Collections were made each day by making five sweeps about three yards long in the water with the dip-net. The specimens were sorted according to sex, and the numbers of eggs and young in the brood pouches of the females were recorded. Mature males were recognizable by the presence of two genital papillae projecting from the lower surface of the seventh segment of the thorax (Pennak, 1953).

All specimens of *C. rivularis* and one hundred of *C. richmondensis laurentianus* are deposited in the collection of the National Museum of Canada. Others are in the Department of Zoology, University of Western Ontario. During the summer of 1961, Mr. M.S. Beverley, and during the summer of 1962, Mr. K.P. Butler, aided in collecting and sorting specimens.

## *Crangonyx rivularis* Bousfield

This species was found only in zone "b" in small, shallow pools in the shade of trees from May 11 to June 24, 1961. The collections are summarized in Table 1. Three males, 3 and 4 mm long, were collected in the middle of May. Twenty-seven females were collected between May 12 and June 24. Three were 5 mm long, one was 7 mm long, and the remainder were 6 mm long. Eggs were found in the brood pouches of 13 females between May 25 and June 18. The numbers of eggs per female ranged from 10 to 33, averaging 19.3.

The status of *C. rivularis* in Ontario has been summarized by Bousfield (1958). He records it from the Thames watershed, which includes the Byron Bog, and notes that it occurs in small ponds in limestone regions in southern Ontario. In the Byron Bog it was found only in small pools beneath trees in zone "b" in the borders of the bog. The lengths of males and females agree closely with those reported by Bousfield, and the period of collection of ovigerous females in the bog, May 25 to June 18, is within the span, April to June, reported by Bousfield as that in which ovigerous females appear.

## *Crangonyx richmondensis laurentianus* Bousfield

From May 8 to September 29, 1961, 987 scuds of this species were collected, comprising 187 adult males, 48 adult females (20% of the adults),

and 752 immatures. From April 17 to November 24, 1962, there were 264 collected, comprising 165 males, 35 females (18% of the adults), and 64 immatures. The seasonal distribution of the various stages in the life cycle, based on combined data for 1961 and 1962, is shown in Fig. 2. This scud was found only in Redmond's Pond.

Males were collected from April 17 to November 24 (1962), except during a period of about one month, September 22 to October 18, when no males were collected in either year (Fig. 2–A). Females were collected from April 19 (1962) until July 16 (1961). After that, no adult females were collected until they were again found from October 18 to November 13 (Fig. 2–B). The seasonal distribution of the males and females is in accord with the report of Bousfield (1958) that ovigerous females and mature males are present from April to June, dying soon after release of young. In the Byron Bog, males persisted later into the season than females. Adults collected in October and November were doubtless progeny of eggs produced in the spring and would live beneath the ice into the following spring. The lengths of the males and females were measured to the nearest millimetre. Of 352 males, 5 were 8 mm long, 24 were 9 mm, 204 were 10 mm, 110 were 11 mm, 8 were 12 mm, and one was 13 mm long. Most of these are within the range of length, 9 to 11 mm, for males of this species noted by Bousfield (1958), but a few were 8, 12, and 13 mm long. Of 83 females, 2 were 11 mm long, 14 were 12 mm, 42 were 13 mm, 22 were 14 mm, and 3 were 15 mm long. Many of these are shorter than the minimum length of females, 14 mm, and none is so long as the maximum length, 18 mm, reported by Bousfield (1958) for females of this species.

Clusters of eggs were present in the brood pouches of 11 females between April 25 (1962) and May 26 (1961) (Fig. 2–C, Table II). The number of eggs per female ranged from 12 to 45, averaging 23.3. Each egg was yellow, spherical, and 0.3 mm in diameter. Hatched young, 2 mm long, were present in the brood pouches of 33 females between May 10 (1962) and June 8 (1961) (Fig. 2–D, Table II). One female, collected on April 23, 1961, contained 16 eggs and 12 young. Of the 43 females which produced eggs and young, 8 were 12 mm long, 24 were 13 mm, and 11 were 14 mm long. Towards the end of the period during which gravid females were collected, the fact that progressively fewer numbers of young were found in the brood pouches (Table II) indicates that in some cases young are released gradually from the brood pouches into the water rather than all at once. No gravid females were found after June 8 in either year. Thus, this species of scud produced only one brood in 1961 and in 1962 in the Byron Bog. Bousfield (1958) reports of the *Crangonyx* group that they breed in winter and spring, and normally produce only one brood per year.

The lengths of immature individuals were measured to the nearest

millimetre, and the times of appearance of each length class are presented in Fig. 2 (E-L) and as follows:

| *Length* | *First Appearance* | | *Last Appearance* | |
|---|---|---|---|---|
| *mm* | *1961* | *1962* | *1961* | *1962* |
| 3 | June 13 | – | June 17 | – |
| 4 | June 17 | – | July 10 | – |
| 5 | June 19 | June 22 | August 20 | August 2 |
| 6 | June 29 | July 11 | August 28 | September 6 |
| 7 | July 11 | July 31 | August 30 | September 17 |
| 8 | July 16 | July 23 | September 8 | September 12 |
| 9 | August 12 | August 1 | August 30 | October 12 |
| 10 | August 19 | September 13 | September 8 | September 13 |

The smallest immatures collected as free-swimming individuals were 3 mm long, and others up to 10 mm long were collected as the season progressed. For most of the length classes represented, the dates of first and last appearance in 1961 averaged about two weeks earlier than those in 1962.

Previous records of the occurrence of *C. richmondensis laurentianus* in Ontario (Bousfield, 1958) are confined to the Precambrian Shield. The Byron Bog lies over Palaeozoic bedrock in southern Ontario at or near the border of the Carolinian Zone (Soper, 1955). Braun (1950) points out that bogs are characteristic of the more northern coniferous forests and that in the Carolinian Zone they are relics in sharp contrast to the surrounding deciduous forest. Bousfield (1958) reports that *C. r. laurentianus* is found along shallow margins of bog ponds and small, typically acidic lakes. The water of Redmond's Pond in the Byron Bog is acidic (Judd, 1957). Thus the presence of the population of this species in the Byron Bog is in keeping with the bog's status as a relic acidic bog in southwestern Ontario.

TABLE I

*Crangonyx rivularis* from pools in Area B

| Date | Males | | Females | | | |
|---|---|---|---|---|---|---|
| | Length | | Length | | | Eggs per female |
| | 3 mm | 4 mm | 5 mm | 6 mm | 7 mm | |
| May 11 ..... | – | 1 | – | – | – | – |
| 12 ..... | – | – | 1 | 1 | – | – |
| 15 ..... | – | 1 | – | – | – | – |
| 17 ..... | 1 | – | – | 1 | – | – |
| 25 ..... | – | – | – | 8 | – | 10,12,13,14,16,16,20,27 |
| | – | – | – | – | 1 | 32 |
| 26 ..... | – | – | – | 1 | – | – |
| 29 ..... | – | – | – | 1 | – | – |
| June 1 ..... | – | – | – | 1 | – | 18 |
| 2..... | – | – | – | 1 | – | – |
| 3..... | – | – | – | 1 | – | 24 |
| 4..... | – | – | – | 1 | – | 33 |
| 13..... | – | – | – | 1 | – | – |
| 18..... | – | – | 2 | – | – | 16 (1♀) |
| | – | – | – | 2 | – | – |
| 19..... | – | – | – | 2 | – | – |
| 20..... | – | – | – | 1 | – | – |
| 24..... | – | – | – | 1 | – | – |
| TOTAL..... | 1 | 2 | 3 | 23 | 1 | – |

## TABLE II

Numbers of Eggs and Young per female in brood pouches of *C. r. laurentianus*

| Date | 1961 | | 1962 | |
|---|---|---|---|---|
| | Eggs | Young | Eggs | Young |
| April 25 | – | – | 23 | – |
| May 10 | 44 | – | – | 18 |
| 11 | 28 | – | – | – |
| 12 | – | – | 12 | 16, 23, 38 |
| 13 | 27 | – | – | – |
| 14 | 32 | – | 12 | 30, 30, 36 |
| 15 | – | – | – | 27 |
| 16 | – | 30 | – | 29 |
| 18 | – | – | – | 12, 15, 22 |
| 19 | 45 | – | – | 11, 12, 13 |
| 22 | – | – | – | 1, 6, 13 |
| 23 | 16* | 12* | – | – |
| 25 | – | 16 | – | – |
| 26 | 14, 16 | 13, 14, 16, 17 | – | – |
| 29 | – | 5, 8 | – | – |
| 30 | – | – | – | 1 |
| June 1 | – | – | – | 1 |
| 2 | – | 3, 6 | – | – |
| 5 | – | 6 | – | – |
| 8 | – | 1 | – | – |

* in one female

FIG. 1

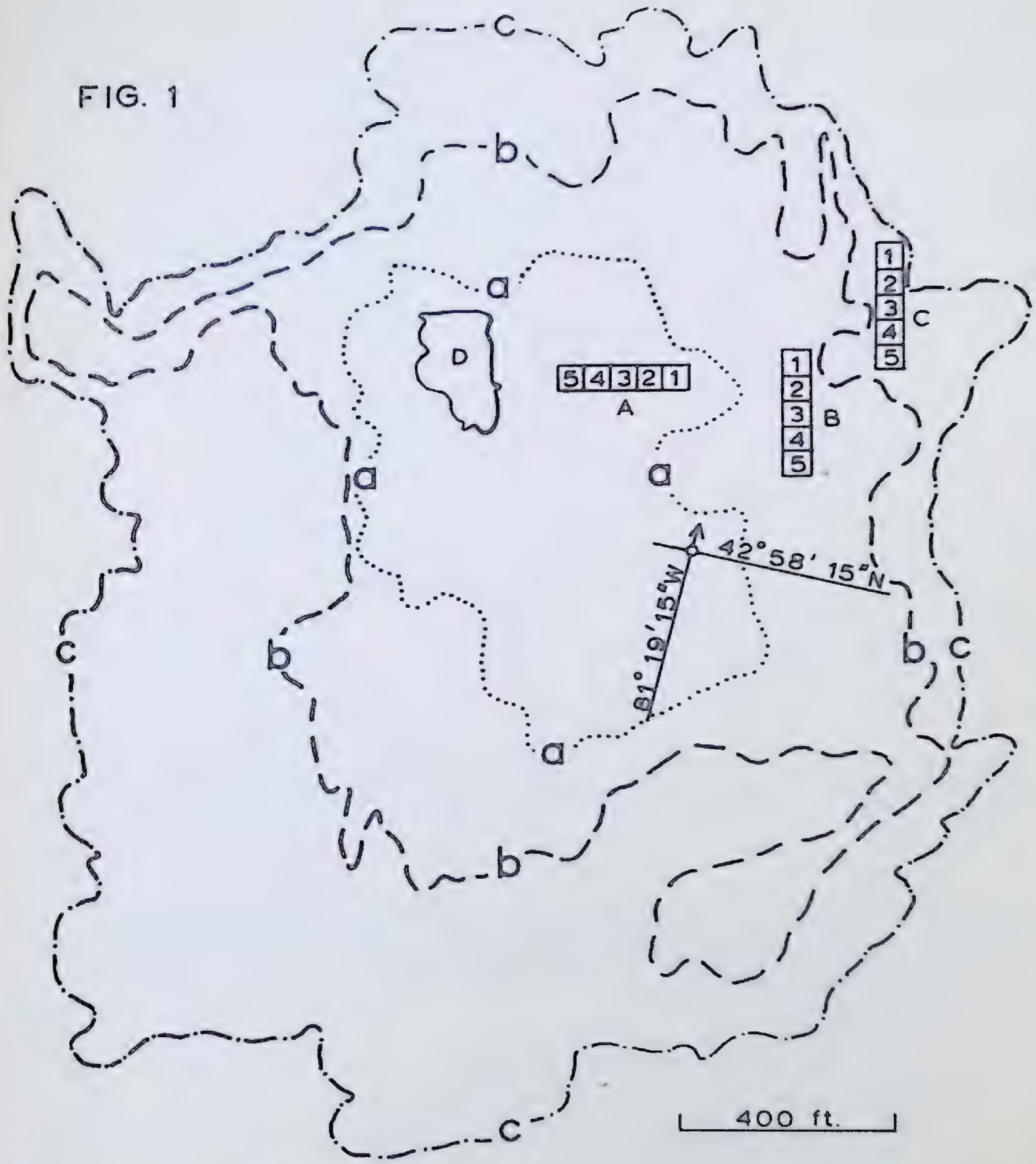


Figure 1. Map of Byron Bog
a-a: outer border of open floating bog
b-b: outer border of lower woods
c-c: outer border of wooded slopes
D: Redmond's Pond
A, B, C, D: collection sites

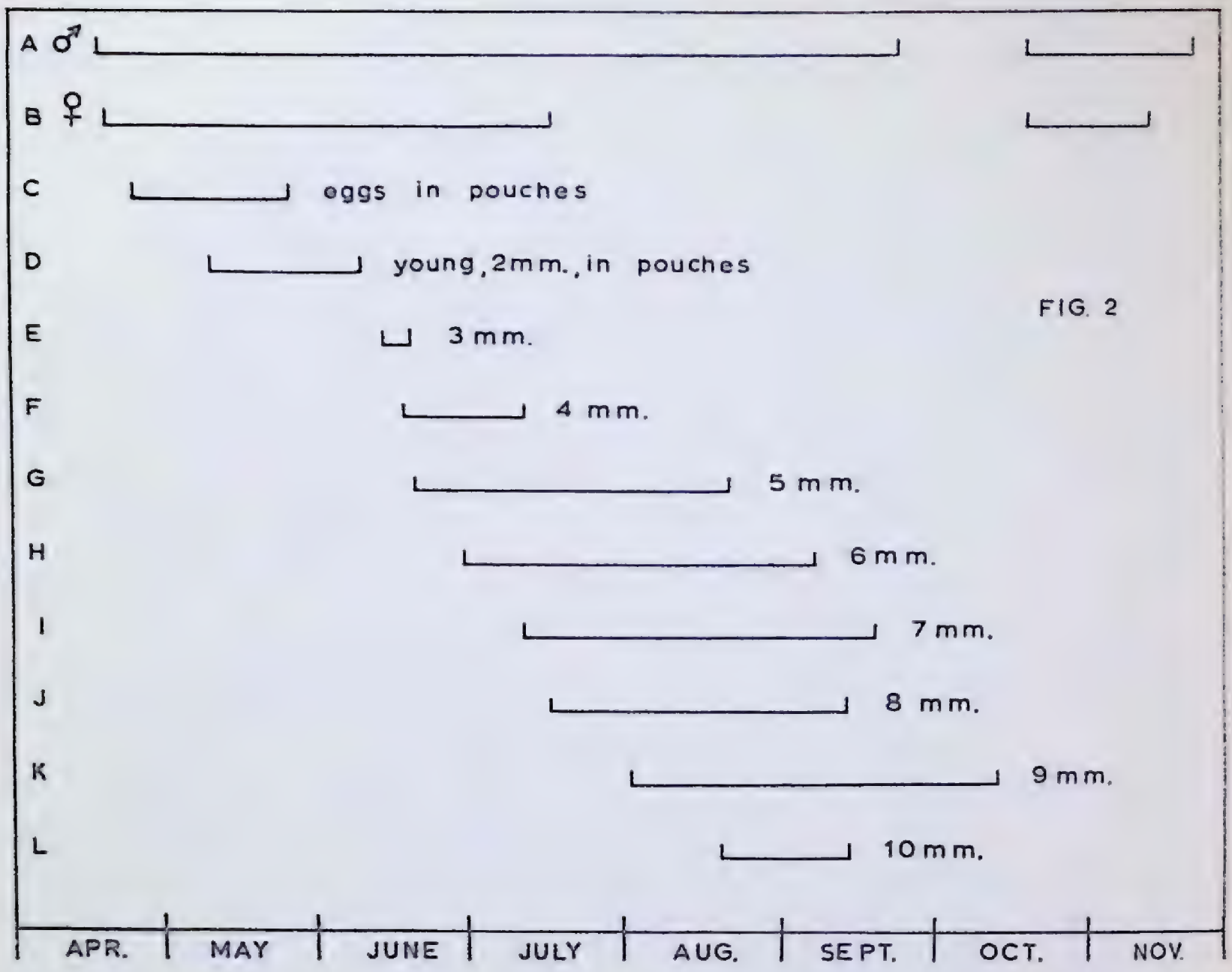


FIG. 2

Figure 2. Seasonal occurrence of stages in life cycle of *C. r. laurentianus* based on combined data of 1961 and 1962.

A: adult males

B: adult females

C: eggs in brood pouches of females

D: young, 2 mm, in brood pouches of females

E to L: free-swimming immatures in water

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SEP 2 1 63

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AND NATIONAL RESOURCES

OTTAWA

NUMBER 21 26 SEPTEMBER, 1963

# EARLY DISCOVERIES OF DINOSAURS

C.M. STERNBERG

The first scientific description of a dinosaur, "Notice on the *Megalosaurus*, the Great Fossil Lizard of Stonesfield," was read by William Buckland before the Geological Society of London on February 20, 1824(1). No specific name was proposed, but there was a good description with illustrations. It was recognized as a reptile, though, of course, the name dinosaur had not yet been coined.

The name *Megalosaurus* was first published by James Parkinson on July 1, 1822(11). No description was given except to say that the specimen was from the calcareous slate of Stonesfield and that it was in the museum at Oxford. No date is given for the discovery, but on page 284, under the heading "Fossil crocodiles and other saurian animals," a footnote states that he has been favoured by the Rev. W.D. Conybeare with a systematic arrangement of the subject of this section and he has introduced it into the text. Under this section he lists *Megalosaurus* (not yet described). He states that drawings had been made of the most essential parts of the animal. As the specimen was collected, prepared, drawn, named, classified, and placed in the museum at Oxford before the article, which was published July 1, 1822, went to press, it appears certain that it must have been discovered before March 1822 when Mrs. Mantell discovered teeth of Iguanodon (2, p. 20). Thus *Megalosaurus* was the first dinosaur discovered in England, as well as the first to be described.

Dinosaur remains and tracks had been found in North America before 1822, but no good description had been published. Dr. G.G. Simpson, in his article on "The Beginnings of Vertebrate Paleontology in North America"

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(13), has drawn attention to three early records of dinosaurs. Apparently the first dinosaur fossil to be reported was that of a large thigh bone found near Woodbury Creek in Gloucester Co., N.J. This was described in a paper by Mr. Matelock and Dr. Wister, read before the American Philosophical Society, October 5, 1787. This probably was the bone of a hadrosaur, but verification is impossible and Simpson states (13, p. 178) that it cannot be accounted a true discovery. The paper was never printed. In Clark's Journal (Lewis and Clark Expedition) an entry for July 25, 1806 (13, p. 171-2) describes the finding of a "fish rib," three inches in circumference and more than three feet long, in the face of a cliff six or seven miles below Pompeys Tower, on the north side of Yellowstone River below Billings, Montana. The Hell Creek beds outcrop in this area, and the "fish rib" was probably that of a dinosaur. In 1820 Nathan Smith reported fossil bones collected by Solomon Elsworth, Jr. in 1818 from red sandstone from the valley of the Connecticut River. They were reported as possibly human. They are still preserved at Yale University and were identified by Lull as dinosaurian (13, p. 166).

In 1800 Pliny Moody of South Hadley, Mass., collected a piece of flagstone on which was impressed a dinosaur track. This was thought to be a bird track, and young Moody exhibited it as the track of Noah's raven (5). In 1836 Prof. Edward Hitchcock published a splendid description of dinosaur tracks under the name Ornithichnites, which at that time were regarded as the tracks of birds (6). Very little was known about dinosaurs then, and it was not until 1842 that Owen coined the name 'Dinosauria' for an order of reptiles (10). The name became anglicized to dinosaur and is now used to cover two orders of reptiles, the Saurischia and the Ornithischia.

Beginning in 1856, Dr. J. Leidy published descriptions of the osseous remains of dinosaurs from Montana (9). In this article he described genus and species and named the types. This might be regarded as the beginning of true scientific description of dinosaurs in North America, though, of course, Hitchcock's splendid description of tracks was much earlier (6).

The first specimen from Canada, to be regarded as dinosaurian, was collected from Prince Edward Island and was described by Leidy in 1854 as *Bathygnathus borealis* (8). In 1905 Case and von Huene, independently showed that *Bathygnathus* was a *Dimetrodon*-like pelycosaur (see Romer and Price (12, p. 321)).

In 1874 G.M. Dawson, acting as geologist on the International Boundary Survey along the Forty-ninth Parallel, collected dinosaur bones from badland exposures on the southern edge of Wood Mountain Plateau in Saskatchewan and along Milk River in Alberta (3), these bones were identified by E.D. Cope and reported on in appendix B of Dawson's report (3, p. 333-6).

In 1881 G.M. Dawson and his assistant, R.G. McConnell, discovered dinosaurs at several localities in southern Alberta (4), and McConnell collected dinosaur bones from Scabby Butte, northwest of Lethbridge, for the Geological Survey Museum at Ottawa (15, p. 168). In 1884 J.B. Tyrrell observed many dinosaur bones in the Edmonton formation, along Red Deer River, and collected the first dinosaur skull in Canada from Knee Hills Creek (14). In 1888 T.C. Weston, of the Geological Survey of Canada staff, made a trip down Red Deer River from the town of Red Deer to the mouth of the river. On this trip he collected a second carnivorous dinosaur skull from the Edmonton formation. He reported the extensive badlands exposure below the mouth of Berry Creek (Steveville), which has yielded so many fine specimens of dinosaurs.

The first systematic collecting of dinosaurs, by a palaeontologist, in Alberta was carried on by L.M. Lambe in 1897-98 and 1901 on Red Deer River below the mouth of Berry Creek. His study of the rather extensive collection was published in 1902 (7).

The first collection of articulated skeletons and large skulls of dinosaurs from Alberta was begun by Barnum Brown for the American Museum of Natural History in 1910. The Sternberg family followed Brown in 1912 and collected many skeletons and skulls from the Edmonton and Old Man formations of Alberta.

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OTTAWA, 1963

Cat. No. R95-5/22

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# Natural History Papers

## National Museum of Canada

DEPARTMENT OF NORTHERN AFFAIRS
AND NATIONAL RESOURCES

OTTAWA

NUMBER 22 11 OCTOBER 1963


## A MICROSAUR FROM THE PENNSYLVANIAN OF JOGGINS, NOVA SCOTIA

Robert L. Carroll*

The order Microsauria was originally established by Dawson (1863, p. 65) for the genus *Hylonomus* from the Westphalian B of Joggins, Nova Scotia, which he considered to be related to reptiles. The order was subsequently (Miall, 1875) placed among the Amphibia. A number of genera from Europe and the United States were later considered to be members of this group, and our current understanding of the order is based entirely on these genera. As was pointed out by Romer (1950) in the latest revision of the Microsauria, the animals originally cited by Dawson are in all probability true reptiles and are not closely related to the genera now considered microsaurs.

Among the animals later (1882 and 1894) included by Dawson in the Microsauria, however, are two or perhaps three genera which can be included within that order as it is currently defined. Sufficient material was uncovered in a study of a collection in the Canadian National Museum made by Bell in 1911 from the Joggins locality to enable a thorough description to be made of one of these genera. Mention will be made of the remaining two genera in a later publication.

I wish to thank Dr. A.S. Romer who suggested this study, Dr. L.S. Russell and Dr. Wann Langston of the National Museum of Canada for the loan of specimens, and the National Research Council of Canada for funds that made this work possible. I should also like to thank Mrs. Stevenson, Curator of Geology at the Redpath Museum, McGill University, where this work was carried out.

*Redpath Museum, McGill University

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## Asaphestera intermedium (Dawson)

*Hylerpeton intermedium* Dawson, 1894, p. 75
*Asaphestera platyris* Steen, 1934, p. 493

In 1894, Dawson described the species *Hylerpeton intermedium*, based on specimen 2.1131 in the Redpath Museum, McGill University. His discussion was brief, and included no illustrations:

> "This species is known as yet only by the mandibles and portions of the skull, which are rather shorter than those of adult individuals of the last species [*Hylerpeton longidentatum*]. The extremity of the mandible and the cranial bones have the same slightly waved surface as in the other species. Mandible three centimeters long and the teeth which are about 15 in each ramus of the lower jaw are simple, with large pulp cavities. Those of the maxillary bone slightly enlarging upwards, and intermediate in form between the long slender teeth of *H. longidentatum* and the thick obtuse teeth of *H. Dawsoni*."

Steen (1934), in her review of the fauna, discovered that there were three distinct skulls among the specimens included in R.M.[1] 2.1131. For that reason, she concluded that Dawson's species was indeterminate. From Dawson's description, however, it is apparent that it applies to only one of the three skulls—one which Steen placed in the species *Asaphestera platyris*; the other two skulls have neither teeth nor jaws preserved. The skull described by Dawson must therefore be retained as the type for the species *intermedium*, although the generic name proposed by Steen must be applied since the species differs significantly from the type species of *Hylerpeton*, *H. dawsoni* Owen, 1862. To avoid subsequent confusion, the number R.M. 2.1131 now applies only to the type of *Asaphestera intermedium*.

The following specimens compose the hypodigm of the species:

R.M. 2.1131. Type. Ventral view of central portion of skull roof, lower jaws, premaxilla, and numerous scales. Figured by Steen, 1934, p. 493, fig. 25 B and plate V fig. 2. Collected by McNaughton, 1893, from division 4, section XII, coal-group 26,[2] Joggins formation, Westphalian B.

R.M. 2.1192. Dorsal portion of posterior skull roof, impression of maxillary teeth. Questionably associated postcranial material includes a scapulocoracoid, humerus, and femur. Skull figured by Steen, 1934, p. 493, fig. 25 A and plate V fig. 3, as type of *Asaphestera platyris*. Collected with R.M. 2.1131.

R.M. 12113. Impression of ventral surface of posterior portion of skull roof. Collected by Dawson, probably from division 4, section XV, coal-group 15, Joggins.

R.M. 12087. Dentary bone. Collected by Dawson, probably from division 4, section XV, coal-group 15, Joggins.

[1] R.M. — Redpath Museum, McGill University
N.M.C. — National Museum of Canada

[2] Joggins section follows Dawson, 1878.

Figure 1. *Asaphestera intermedium*. Type, R.M. 2.1131. X2
A. Ventral view of skull roof.
B. Counterpart of A.
List of abbreviations follows text.

N.M.C. 10041. Skull, lower jaws, clavicles, humeri, section of vertebral column, pelvis, and numerous scales. Collected by Bell, 1911, from division 4, section XII, coal-group 26, beds 246-247,[1] Joggins.

N.M.C. 10042. Ventral view of skull roof, humeri, pterygoid, numerous scales. Collected by Bell, 1911, division 4, section XII, coal-group 26, beds 246-247.

N.M.C. 10043. Skull and jaw, humeri, clavicles, numerous scales. Collected by Bell, 1911, division 4, section XII, coal-group 26, beds 246-247.

N.M.C. 10044. Impression of dorsal surface of posterior portion of skull roof. Collected by Bell, 1911, division 4, section XXI, coal-group 10, beds 119-120.

Several additional specimens in the Dawson collection may belong to this species but are too fragmentary or belong to individuals too young for definite determination. All specimens came from erect trees.

In general, the characters of this microsaur are similar to those of the 'normal' type of microsaur discussed by Romer (1950). All the skulls are crushed flat, and their configuration can be only approximately reconstructed. If they are reconstructed on the pattern of gymnarthrids (Gregory, Peabody and Price, 1956), the dimensions of the largest skull would be 41 mm long, 36 mm in greatest width, and 19 mm from the level of the quadrates to the top of the skull roof. The external surface of the cranial bones is finely sculptured with lines radiating from the centres of ossification. Large orbits are located about midway along the length of the skull. There is, of course, no otic notch. Grooves for lateral line canals run along the upper surface of the dentary and surangular, and on the maxilla. Numerous pits are present in the premaxilla and the anterior portion of the lower jaw. The skull table, in common with embolomeres and primitive captorhinomorphs, was not firmly connected to the cheek region and is frequently found displaced from the remainder of the skull. The postfrontal, postorbital, and jugal overlap one another rather than being suturally connected, and the supratemporal is freely movable on the squamosal.

The position and relative size of the cranial bones are similar to those of the gymnarthrids. The supratemporal (termed tabular by Steen) is large and is broadly in contact with the postfrontal and postorbital. The supratemporal does not extend over the occiput as it does in the gymnarthrids and *Pantylus*. The undersurface of the bone is recessed for accommodation of the otic bone and the squamosal. Large postparietals extend to the back of the skull roof but do not exhibit a break in curvature at the edge of the occiput. R.M. 2.1192 shows such a break, but the specimen is unique in this respect, and its appearance is apparently a

[1] Logan's section, in Fletcher, 1908.

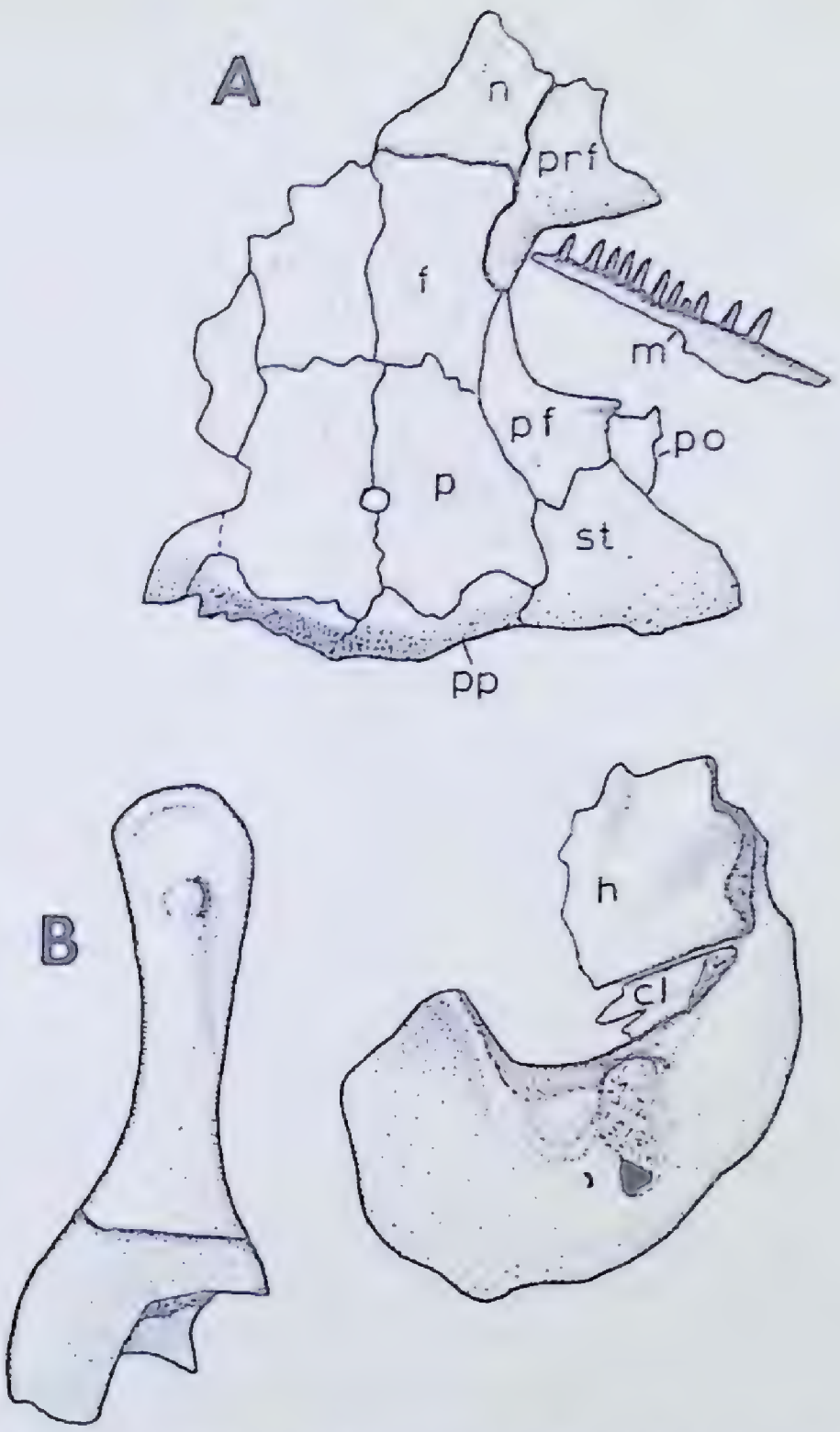


Figure 2. *Asaphestera intermedium*. R.M. 2.1192. X2
A. Dorsal view of skull roof.
B. Scapulocoracoid, humerus and femur.

Figure 3. *Asaphestera intermedium*. R.M. 12113.
Impression of lower surface of skull roof X2.

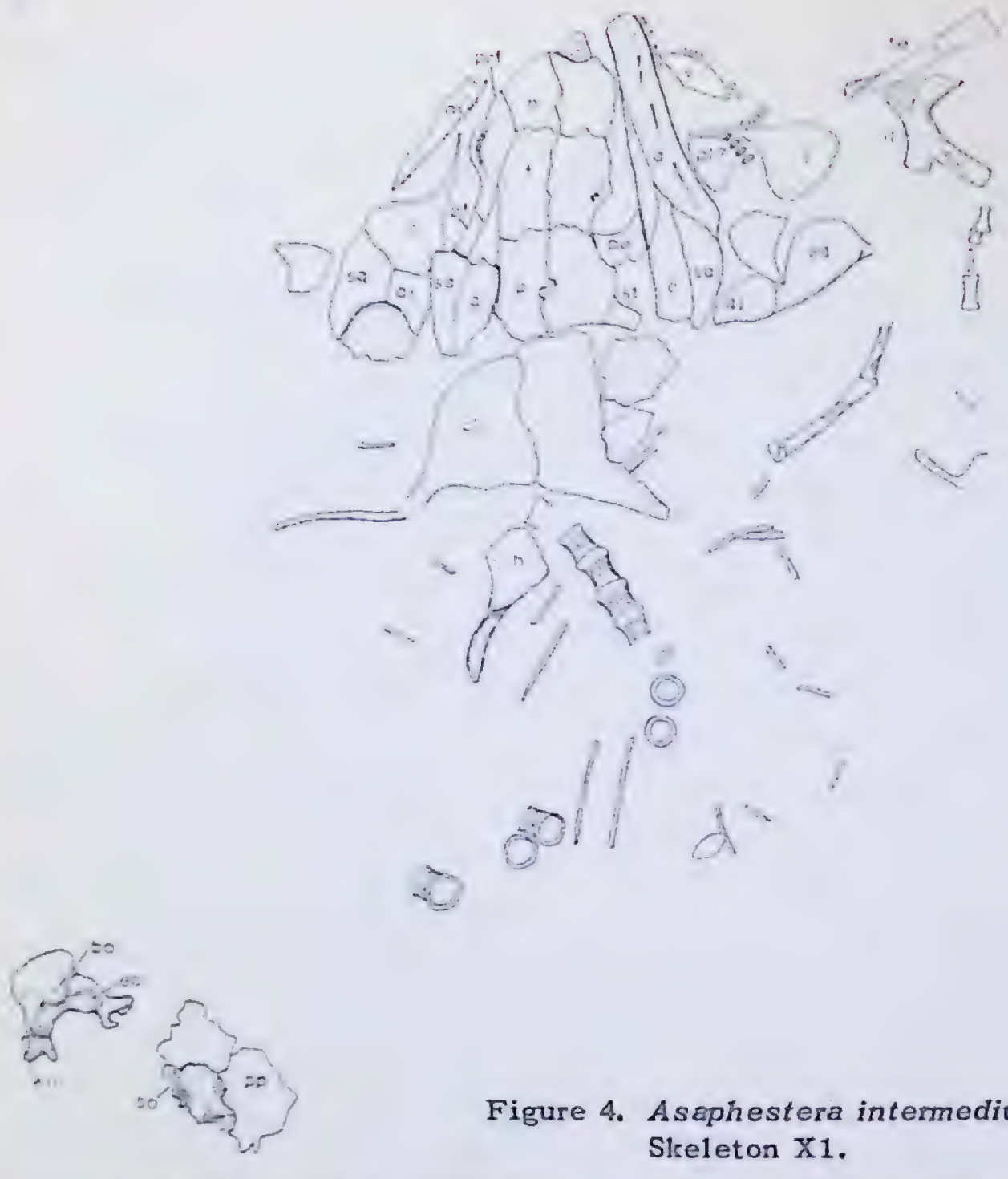

Figure 4. *Asaphestera intermedium*. N.M.C. 10041. Skeleton X1.

result of post-mortem distortion. The parietals are the largest bones in the skull roof and bear a prominent pineal foramen. The remainder of the skull roof is made up of the frontals and nasals. The undersurface of the frontals is rugose and is frequently broken laterally where contact was made with the braincase. The squamosal and quadratojugal form the posterior margin of the sides of the skull and extend unsculptured portions over the occipital surface, as do these bones in the gymnarthrids and *Pantylus*. The jugal is a more extensive bone than it is in the later microsaurs and reaches well above the dorsal margin of the quadratojugal. A prominent groove near the orbital margin of the jugal fails to reach the postorbital. The pre- and postfrontals meet broadly above the orbits. The prefrontal, which extends anteriorly to the nasal bone, is strongly concave on the ventral surface. The lacrimal bone is not identifiable in any of the specimens.

The maxilla extends anteriorly from beneath the middle of the jugal. It bears approximately thirty teeth, each a straight peg ending in a point. The length of the teeth increases gradually anteriorly. The premaxilla bears about eight teeth of uniform size, comparable to the largest teeth in the maxilla. The premaxilla of *Asaphestera* lacks the distinctive tripartite form common to the premaxillae of primitive reptiles.

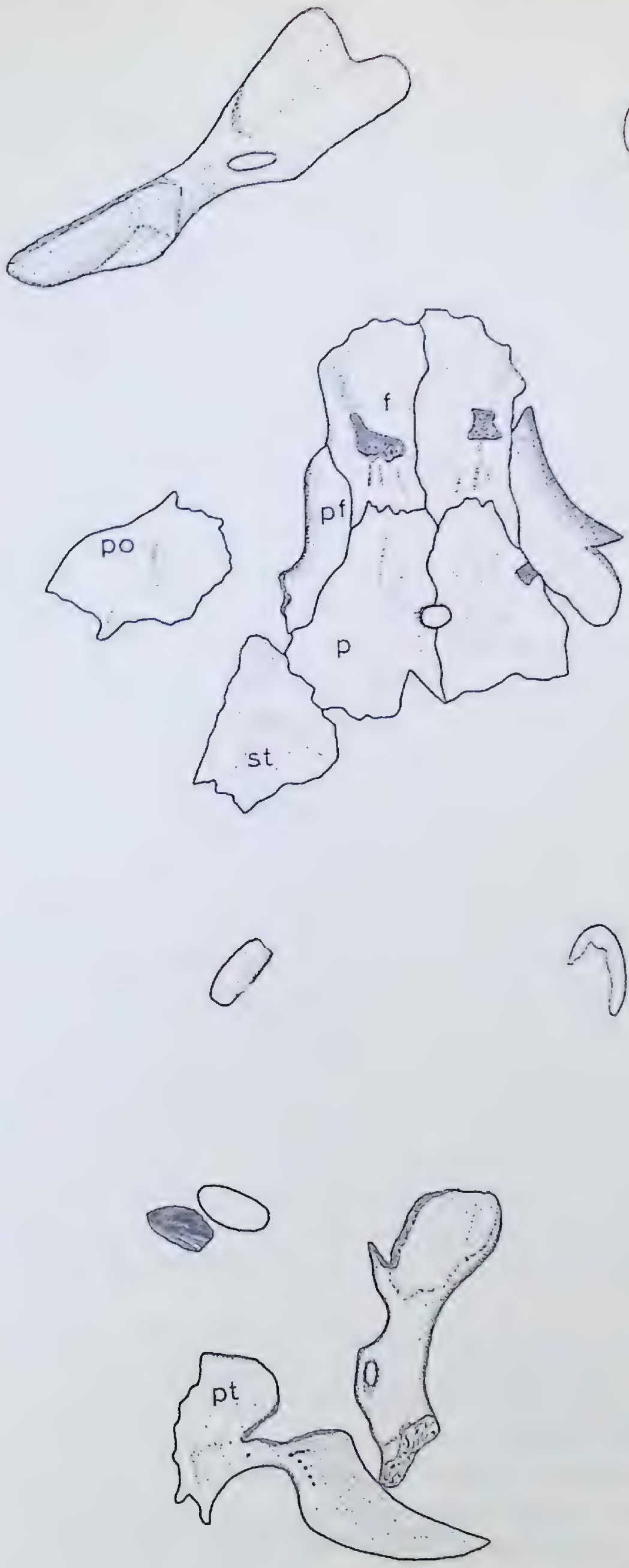


Figure 5. *Asaphestera intermedium*. N.M.C. 10042.
Ventral view of skull roof, humeri, and pterygoid X2.
Right humerus is drawn from counterpart.

In none of the specimens is the palate well preserved. An imperfect pterygoid is present in N.M.C. 10042, resembling that of other microsaurs in lacking a transverse flange, a structure already developed in Joggins reptiles. Several small foramina are present near the medial margin of the pterygoid, just anterior to the area of articulation with the braincase. They may have provided passage for branches of the palatine ramus of the VIIth nerve. No such openings have been described in any other microsaurs. Fragments of the vomer, palatine, and perhaps ectopterygoid are present with skull N.M.C. 10041. Some, if not all, of these bones bear small denticles. One large tooth is present on the margin of the internal naris on an isolated fragment of the vomer in N.M.C. 10043.

What is present of the occipital region in N.M.C. 10041 is very similar to that of *Pantylus* and the gymnarthrids. The exoccipitals and basioccipital together form a very wide, strap-shaped condyle, entirely distinct from that of any primitive reptile. The basioccipital, however, does not appear to be so closely integrated with the condyle as in later microsaurs. Although the otic bones are not present, their configuration must have resembled that of other described microsaurs because of the similarity of the remainder of the back of the skull. A supraoccipital bone can be seen beneath the postparietals in the same specimen. It is much less extensive than is that bone in primitive reptiles, and, in consequence, the foramen magnum passes just beneath the skull roof. The anterior portion of the braincase is not present in any of the skulls, nor is the quadrate.

The lower jaws are present in several of the specimens. The teeth are similar in size and number to those of the upper jaw but, unlike them, are covered externally for a large portion of their length by the dentary. This makes an exact tooth count impossible since some of the posterior teeth are completely covered. In addition to lateral line grooves on the lateral surface, the dentary also has a number of small pits on its anterior end and a rugose area near the symphysis. The remainder of the lateral surface of the jaw is made up of a splenial or postsplenial, a very large angular, and a smaller surangular, which bears a small lateral line groove. The articular was not visible, but from the general configuration of the jaw, it must have been located near the ventral margin, as in other microsaurs.

A large portion of the postcranial skeleton is present in N.M.C. 10041 and 10043. The vertebral column, which is disarticulated in both specimens, shows only a small number of isolated units. Each vertebra consists of a thin-walled centrum fused to an unswollen neural arch. The neural spines are considerably shorter than those of romeriid reptiles but more prominent than those of many captorhinids. The centra bear longitudinal ridges which distinguish them from the centra of contemporary reptiles. No intercentra

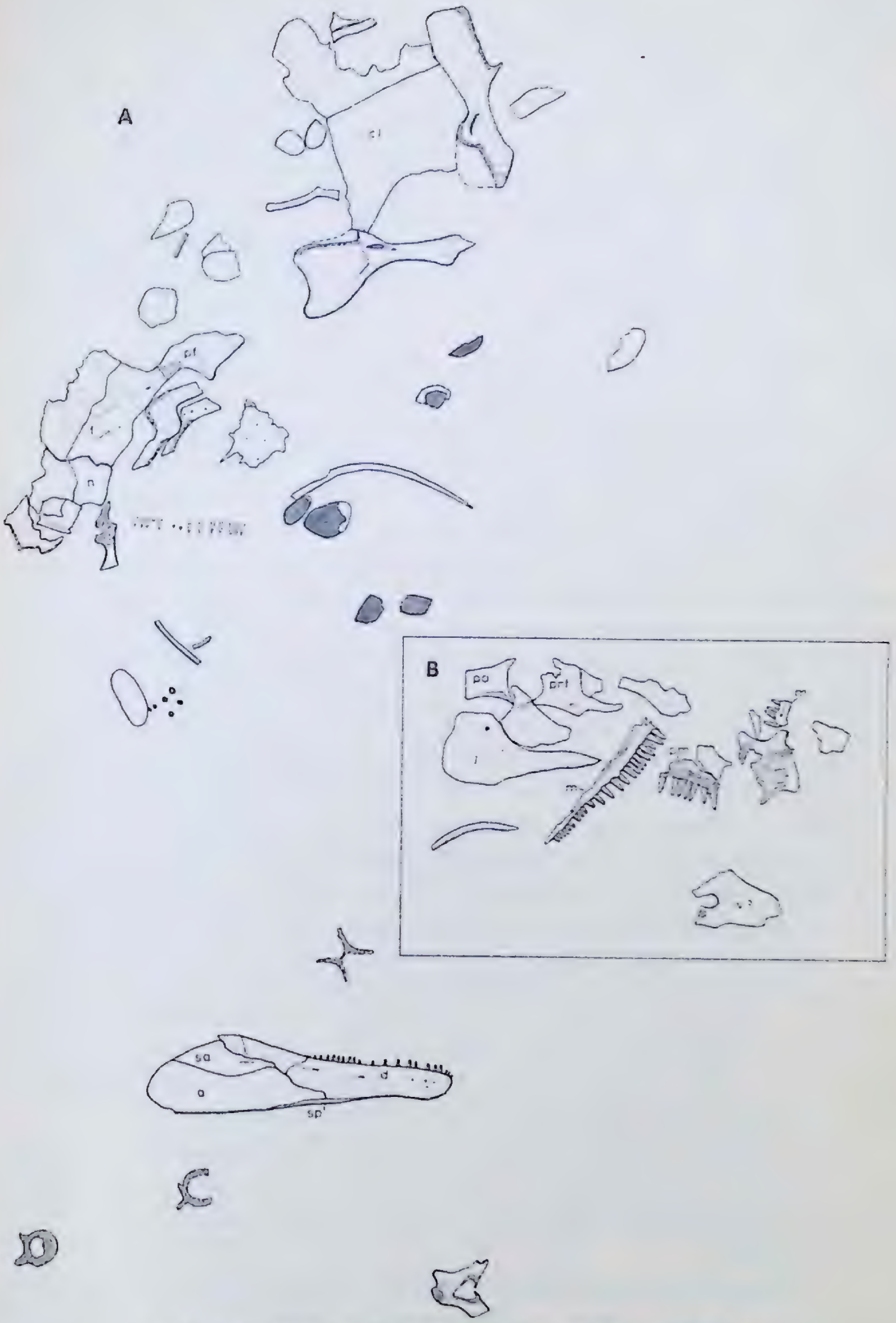


Figure 6. *Asaphestera intermedium*. N.M.C. 10043. X1
A. Skeleton.
B. Counterpart of A.

are visible, and the configuration of the centra suggests that they were not present. Scattered ribs are present in several of the specimens, but one can determine little of their structure or mode of articulation.

A single scapulocoracoid was preserved in association with R.M. 2.1192. It closely resembles those attributed to the Fort Sill gymnarthrids. There does not appear to be a supraglenoid foramen, however, although the area of the supraglenoid buttress is well preserved. The shape of the coracoid foramen is not possible to determine since the surface of the surrounding bone has been eroded. The small glenoid foramen appears to be located somewhat posterior to its position in the Fort Sill specimens. As in these specimens, there is a clearly defined depression anterior and medial to the glenoid fossa. As in the Fort Sill specimens, the anterior margin of the scapulocoracoid is missing and may have been completed in cartilage. The dermal portion of the shoulder girdle is poorly represented. Only the large, unsculptured ventral region of the clavicles is well preserved, along with fragments of the stems. Simply from a consideration of the size of the animal, it is unlikely that the bone labelled "interclavicle" by Steen in the type was actually this unit.

Humeri are present with several of the skulls. They do not at all resemble the humeri of gymnarthrids but are similar to those of *Pantylus*. The bones have massive distal and proximal articulating areas, set at nearly a right angle. There is relatively little shaft between them. A large entepicondylar foramen is located just distal to the middle of the bone. Neither of the articulating surfaces is well preserved in any of the specimens. A portion of either the radius or ulna and several toe bones are present in N.M.C. 10041, but they are too fragmentary for description.

The left ilium of N.M.C. 10041 is the only portion of the pelvic girdle that is preserved. There is a prominent posterior projection and a smaller dorsal prong. A dorsal extension has not been noted in any other microsaur that has been described. It is not a surprising feature, however, since it is present in many primitive tetrapods. A femur is present in N.M.C. 10041, poorly preserved but resembling that of the gymnarthrids in general features. A somewhat better preserved femur accompanies R.M. 2.1192. As in the gymnarthrids, there is a prominent internal trochanter. The distal portion of the bone is badly crushed, preventing comparison. The remainder of the hind limb is not preserved in any of the specimens.

The limbs are fairly large in proportion to the remainder of the body, and the portions preserved are well ossified. There can be no doubt that, despite the presence of lateral line grooves, *Asaphestera* was a primarily terrestrial animal.

Numerous scales were preserved with the specimens. All are oval in shape and smoothly convex on the external surface, and are covered with a pattern of concentric ridges internally.

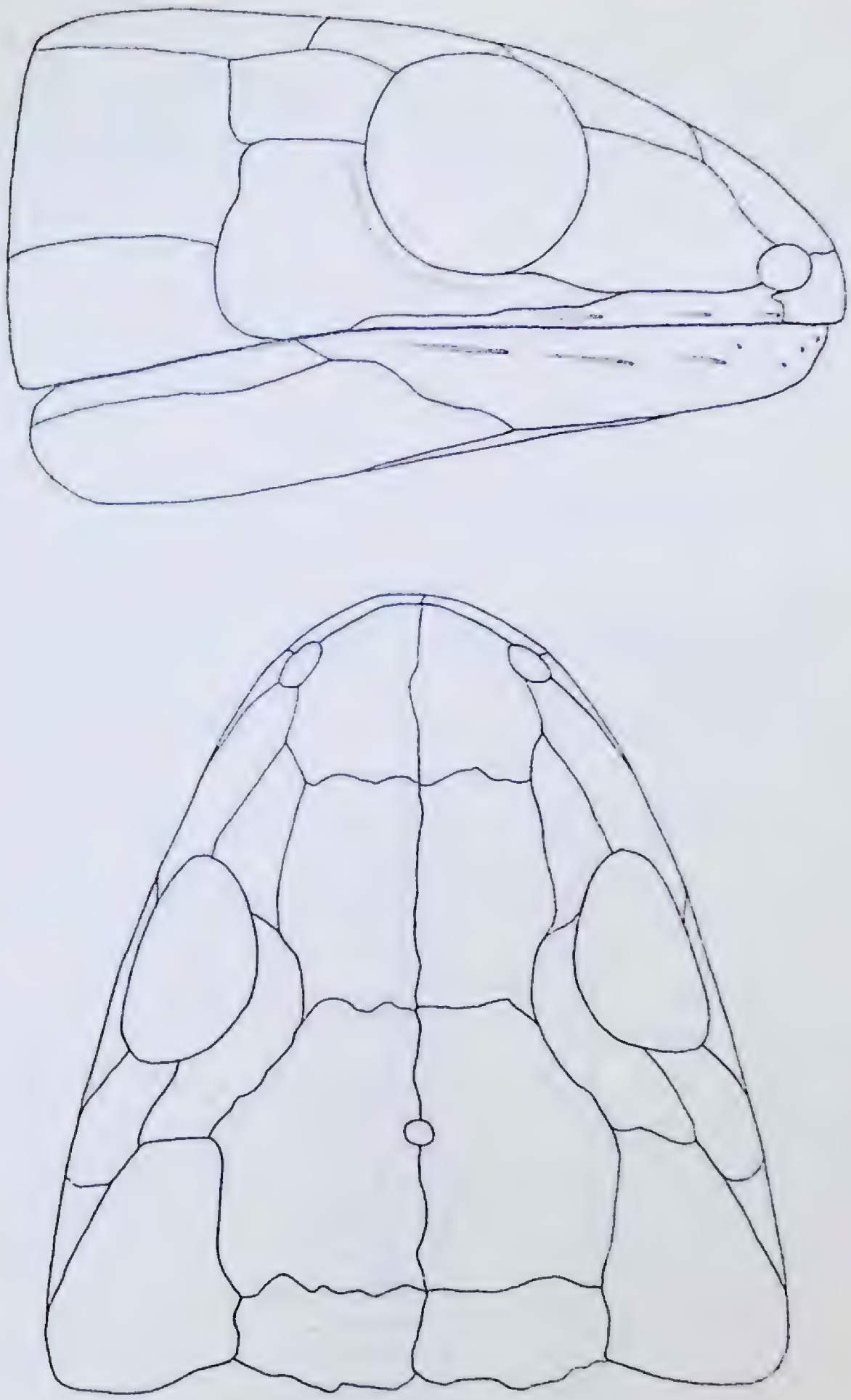

Figure 7. *Asaphestera intermedium*. Restoration of skull X2.

From the description of *Asaphestera intermedium*, it is evident that quadruped microsaurs were distinct from reptiles in the Middle Pennsylvanian and that no close relationship between the two groups can be suggested.

Among the microsaurs, the closest relationship of *Asaphestera* appears to be with the Linton genus *Tuditanus*, currently being studied by Dr. Baird at Princeton and the author. Both of these genera have well-developed limbs and a large number of peglike marginal teeth.

## ABBREVIATIONS USED IN FIGURES

| | |
|---|---|
| a | angular |
| bo | basioccipital |
| cl | clavicle |
| d | dentary |
| eo | exoccipital |
| f | frontal |
| fe | femur |
| h | humerus |
| il | ilium |
| j | jugal |
| l | lacrimal |
| m | maxilla |
| n | nasal |
| p | parietal |
| pf | postfrontal |
| pl | palatine |
| pm | premaxilla |
| po | postorbital |
| pp | postparietal |
| prf | prefrontal |
| pt | pterygoid |
| qj | quadratojugal |
| sa | surangular |
| so | supraoccipital |
| sp | splenial |
| sq | squamosal |
| st | supratemporal |
| v | vomer |
| XII | opening for nerve XII |

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NATIONAL MUSEUM OF CANADA NATURAL HISTORY PAPERS

# Range Extensions of Some Mammals from Northwestern Canada

Phillip M. Youngman

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ROGER DUHAMEL, F.R.S.C.
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# RANGE EXTENSIONS OF SOME MAMMALS FROM NORTHWESTERN CANADA

PHILLIP M. YOUNGMAN

A study of the mammals of Yukon Territory and adjacent Northwest Territories, initiated by the author in 1960, has thus far resulted in the acquisition of over 2,000 specimens by the National Museum of Canada. Many of these and some older specimens in the collection that are of distributional and taxonomic interest are reported upon here.

In addition to specimens collected by staff members of the Museum, this paper is based on collections generously donated by Dr. Robert L. Rausch, Chief, Zoonotic Disease Section, United States Public Health Service, Arctic Health Research Center, Anchorage, Alaska (collectors: R.L. Rausch; F.S.L. Williamson); and by Dr. George P. Holland, Director, Entomology Research Institute, Agriculture Department, Ottawa (collectors, R.E. Leech; J.E.H. Martin, P.J. Skitsko).

All measurements are in millimetres. Catalogue numbers are from the National Museum of Canada.

**Sorex cinereus cinereus** Kerr – Four specimens (29853-55 and 29857) from Old Crow, Yukon Territory, and one specimen (29856) from Driftwood Creek, 60 mi. NE Old Crow, extend the known range of the subspecies almost 300 miles to the north of the previous northernmost record, Dawson (near Stewart River), Yukon Territory (Jackson, 1928:50). These specimens were collected by F.S.L. Williamson between May 29 and July 14, 1957.

Other noteworthy records are four specimens (23703-06), collected by J.E.H. Martin between August 3 and August 15, 1951, at Rampart House, Yukon Territory; nine specimens (24360, 24361, 24363-67; 26207, 26209) collected by T.H. Manning and A.H. Macpherson from Aklavik, Northwest Territories, between October 5 and November 23, 1952; two specimens (30298-99) collected by G.D. Tessier, July 9 and 20, 1962, Horn Lake, 37 mi. NW Fort McPherson (lat. 67°46', long. 136°2') 1,000 feet; and one (30300) collected by P.M. Youngman July 13, 1962, floodplain of Rat River, 1 mi. S Horn Lake and 37 mi. NW Fort McPherson (lat. 67°44', long. 136°00') 820 feet.

As pointed out by Anderson and Rand (1945: 63), *S. c. cinereus* and *S. c. ugyunak* are easily separated by colour, length of skull, and length of tail. They had only one specimen from Aklavik that they suspected was *S. c. cinereus*. Our larger series confirms this identification.

**Sorex cinereus ugyunak** Anderson and Rand – A specimen (24445) collected August 17, 1951, by T.H. Manning from Head Point near Herschel Island provides the only record of this subspecies from Yukon Territory. *Measurements:* 87, 26, 10; condylobasal length 15.6; maxillary breadth 4.2.

**Sorex arcticus tundrensis** Merriam – The only previous records of this species from Yukon Territory are a single specimen from Coal Creek (Osgood, 1909: 58) and another from Fortymile (Jackson, 1928: 74).

An adult male (30297) from Firth River, 15 mi. S mouth of Joe Creek (lat. 68°49' 30", long. 140°33' ) 1,560 feet, collected by P.M. Youngman, August 3, 1962, is the third and northernmost record for the Yukon.

The specimen is tentatively referred to *tundrensis*, although it is slightly paler than specimens in comparable pelage from the Northwest Territories: Toker Point, Beaufort Sea; Reindeer Station; and Tuktoyaktuk.

**Microsorex hoyi intervectus** Jackson – On July 31, 1962, R.E. Leech collected an old adult male (30646) from 14 mi. E Dawson City, 1,300 feet, Yukon Territory. *Measurements:* 88, 31, 10.5, 5.35 gm; condylobasal length 14.8; maxillary breadth 4.5; palatal length 5.8; maxillary tooth row 4.8.

This specimen is from almost midway between the known ranges of *M. h. eximius* and *M. h. intervectus*, a supposed hiatus of 450 miles. It resembles specimens of *M. h. intervectus* from the southern Yukon in colour, but it is cranially slightly larger, possibly indicating intergradation with *M. h. eximius* to the West.

**Ochotona collaris** (Nelson) – Four specimens (30301-04) collected by P.M. Youngman and G.D. Tessier between July 2 and July 7, 1962, from Horn Lake, 37 mi. NW Fort McPherson (lat. 67°46' , long. 136°2' ) 1,000 feet, Yukon Territory, extend the known range of this species approximately 300 miles northwest of the previous northernmost sight record from Little Keele River, Mile 63E Canol Road, Northwest Territories, and the northernmost specimen from Headwaters of the Carcajou River, Mile 111E Canol Road, Northwest Territories (Rand, 1945: 47).

Other specimens from the Yukon have been collected from 13 mi. S of Chapman Lake (lat. 64°38' , long. 138°24' ), 4,000 feet, by P.M. Youngman and G.D. Tessier (29409-17). And from North Fork Pass, Ogilvie Mountains, 4,100 feet by R.E. Leech (30647-55).

All specimens agree in cranial characteristics and in colour with specimens from the southern Yukon.

**Peromyscus maniculatus borealis** Mearns – Two specimens (29497-98), collected by P.M. Youngman on June 30, 1961, 16 mi. E Dawson, 1,500 feet, Yukon Territory, and eight specimens (30660-67), collected by R.E. Leech, June 30, 1962, junction of Klondike and North Klondike Rivers (lat. 64°01' , long. 138°45' ) 1,300 feet, Yukon Territory, extend the known

range of the species in the Yukon some 110 miles to the northwest of the previous northernmost record from the mouth of the Macmillan River (Osgood, 1909: 77). Hall and Kelson (1959: 614) erroneously plot the Fifty Mile River specimens of Osgood (loc. cit.) at Fiftymile Creek some 300 miles to the northwest.

These specimens are assigned to *P.M. borealis* on the basis of lighter colour and shorter tail length, characters that seem to be most reliable in separating *P. m. borealis* from *P. m. algidus*. Measurements of five males from Junction of Klondike and North Klondike Rivers (lat. 64°01', long. 138°45'), 1,300 feet average, total length 174.2 (165-190); length of tail 79.2 (76-89); length of hind foot 22; greatest length of skull 26.3 (25.4-27.2); length of maxillary tooth row 4.2 (4.1-4.3).

**Microtus pennsylvanicus drummondi** (Audubon and Bachman) – A specimen (29927) from 12 mi. S Johnson Creek, Porcupine River, Yukon Territory, collected by F.S.L. Williamson, September 8, 1957, extends the known range of the species in the Yukon approximately 170 miles north of the previous northernmost record from the Chandindu River (Hall and Kelson, 1959: 726). On the basis of colour this specimen is tentatively assigned to *M. p. drummondi*.

Hall and Kelson (1959: 725) mistakenly plot the specimen from Aklavik, Northwest Territories, as a locality in northwest Yukon.

**Microtus longicaudus vellerosus** J.A. Allen – Three specimens (30434-36) collected by G.D. Tessier, July 3 and 5, 1962, at Horn Lake, 37 mi. NW Fort McPherson (lat. 67°46', long. 136°2'), 1,900 feet, Northwest Territories, and three specimens (30437-39) collected by P.M. Youngman, July 17, 1962, 2½ mi. N Horn Lake and 37 mi. NW Fort McPherson, extend the known range of the species to a latitude 25 miles north of the previous northernmost record from Rampart House, Yukon Territory (Banfield, 1961: 263).

Other significant records, from Yukon Territory, are one specimen (29640) from Benson Creek, 28 mi. ENE Dawson, 2,400 feet, collected by P.M. Youngman, August 15, 1961; two specimens (29901-02) from 2 mi. beyond Canadian Customs, Taylor Highway, collected by R.L. Rausch, August 10, 1956; two specimens (29903-04) from Dawson City, collected by Rausch, August 10, 1956; one specimen (30698) from North Fork Pass, Ogilvie Mountains, collected by P.J. Skitsko, June 10, 1962; two (30696-97) from North Fork Crossing, Mile 43, Aklavik Road, 3,500 feet, collected by R.E. Leech, July 2, 1962; and two (30699-700) from North Fork Crossing, Mile 42, Aklavik Road, 3,300 feet, collected by Skitsko, July 3, 1962.

The above specimens are similar in cranial characteristics and in colour to specimens from southern Yukon and northern British Columbia.

**Microtus miurus** Osgood – Previous records of this species in Canada are two specimens from Tepee Lake, Yukon Territory; two from head of Kluane Lake, Yukon Territory (Banfield, 1960: 2), and four from near headwaters of Little Keele River, 5,500 feet, 82 mi. W Mackenzie River on Canol Road, Northwest Territories (Rand, 1945: 42).

Ninety-three specimens (30440-532), collected by P.M. Youngman and G.D. Tessier between July 25 and August 10, 1962, from Firth River, 15 mi. S mouth of Joe Creek (lat. 68°49' 30", long. 140°33'), 1,500-1,600 feet, Yukon Territory, and British Mountains, 20 mi. SE mouth of Joe Creek (lat. 68°47', long. 140°14'), 2,200-2,700 feet, extend the known range of this species in Canada approximately 450 miles to the northwest.

Other noteworthy records from Yukon Territory are fifty specimens (29641-91), collected by P.M. Youngman and G.D. Tessier between July 24 and August 30, 1961, 13 mi. S Chapman Lake (lat. 64°38', long. 138°24') 3,400 feet, and 20 mi. S Chapman Lake (lat. 64°35', long. 138°13') 4,200-5,500 feet; also fifteen specimens (29692-706), collected by Youngman and Tessier, August 30, 1962, Kluane Range, 25 mi. SSE Destruction Bay, 6,400 feet, and eight specimens (27911-18) collected by S.D. MacDonald and D.H. Johnston, September 9 and 11, 1960, from approximately the same locality as the preceding specimens (Sheep Mountain, Alaska Highway, Mile 1061, 5,500 feet).

Subspecific assignment must await revisionary studies now in progress by the writer.

**Synaptomys borealis dalli** Merriam – A young male (29880) collected by F.S.L. Williamson, June 1, 1957, at Old Crow, Yukon Territory, and a male (23721) collected by J.E.H. Martin, August 16, 1951, at Rampart House, Yukon Territory, extend the known range of the species 50 miles north of the latitude of the previous northernmost record from Bettles, Alaska (Hall and Kelson, 1959: 767) and are the most northern records of *Synaptomys* in North America.

Other noteworthy northern records from Yukon Territory are four specimens (30668-71) from North Fork Crossing, Mile 43, Aklavik Road, Ogilvie Mountains (lat. 64°27', long. 138°14') at 3,500 feet, collected by R.E. Leech, July 5, 1962.

The above specimens resemble specimens from southern Yukon in colour and in size but differ in minor cranial details that appear to be of only infrasubspecific value.

**Dicrostonyx torquatus** Pallas – Seven specimens (29499-505) collected by P.M. Youngman and G.D. Tessier between August 3 and August 20, 1962, 20 mi. S Chapman Lake (lat. 64°35', long. 138°13'), 5,500 feet, Yukon Territory, extend the known range of the species in the Yukon some 350 miles to the south of the only published record for Yukon Territory from Herschel Island (Hall and Kelson, 1959: 767) and provide a southernmost

record for eastern Alaska, Yukon Territory, and western Mackenzie District. Further collecting is needed before subspecific assignment can be made.

**Zapus hudsonius hudsonius** (Zimmermann) – Five specimens (30793-97) from 14 mi. E Dawson City, 1,300 feet, Yukon Territory, collected between July 29 and August 3, 1962, by R.E. Leech and P.J. Skitsko, extend the known range of the species in the Yukon approximately 190 miles northwest of the previous northernmost record from the forks of Macmillan River (Hall and Kelson, 1959: 773).

**Odocoileus hemionus hemionus** (Rafinesque) – In 1945 Clarke (unpub. MS.) recorded the first deer in Yukon Territory. His records were based on secondhand reports of sightings on the Nisutlin River near Teslin. Rand (1945: 76) lists these as *O. h. sitkensis* from "the Teslin and Little Atlin Sections of southern Yukon...."

Both Anderson (1946: 176) and Miller and Kellogg (1955: 799) have perpetuated this subspecific identification. Hall and Kelson (1959: 1007) also list the Nisutlin River sighting and the incorrect Little Atlin record as *sitkensis*.

In the fall of 1962 J.B. Fitzgerald picked up a deer skull at Richtofen Island, Lake Laberge, Yukon Territory. This specimen is a male (29387) with recently replaced premolars. *Measurements:* basilar length 262; length of nasals 36; greatest width of nasals 36; zygomatic breadth 114; orbital width 80; mastoidal breadth 86; maxillary tooth row 88; palatal breadth 50; greatest and least width of anterior process of jugal below lacrimal, 20 and 10 respectively.

This specimen in no way agrees with the descriptions of *sitkensis* or *columbiensis* given by Cowan (1936: 207, 208, 225, 226) but agrees cranially with *hemionus* in all but palatal breadth.

Recent sight records from the Yukon include, "March 3, 1962...10 deer in the Tarfu Lake area just east of the Atlin Road," by J.B. Fitzgerald and the following records by T.O. Connolly, 1960, "30 deer, 15 miles downstream from here" (Ross River); and October 1961, "a big buck about 2 miles this side of Johnsons Crossing."

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Number 24 April 1, 1964

NATIONAL MUSEUM OF CANADA **NATURAL HISTORY PAPERS**

# The Northern Prairie Skink in Manitoba A Possible Relic Population

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Department of the Secretary of State

ROGER DUHAMEL, F.R.S.C.
QUEEN'S PRINTER AND CONTROLLER OF STATIONERY
OTTAWA, 1964

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# The Northern Prairie Skink in Manitoba
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## INTRODUCTION

The most recent maps depicting the distribution of the Northern Prairie Skink, *Eumeces s. septentrionalis*, show the northern apex of its range as including the eastern two-thirds of North Dakota, all of southwestern Manitoba (Smith, 1946, p. 505) and in some cases (Smith and Slater, 1949, p. 446; Conant, 1958, p. 322) the extreme southeastern corner of Saskatchewan.

Field work for the National Museum of Canada in southeastern Saskatchewan (1959) and southwestern and southcentral Manitoba (1960) had indicated that this concept of the range is overgenerous. All existing Canadian specimens of this species have been examined, all literature references reviewed, and reports and observations obtained from naturalists in the two provinces. Results of this investigation are reported below.

## LITERATURE RECORDS

Seton's (1918) list of the reptiles and amphibians of Manitoba made no mention of lizards.

Criddle (1919) reported additions to Seton's Manitoba list, commenting "we have at least one Swift *Sceloparus* [*sic*] sp? which inhabits wet or low lands." Although he apparently had no specimens at that time, *E. septentrionalis* is the species referred to (see below).

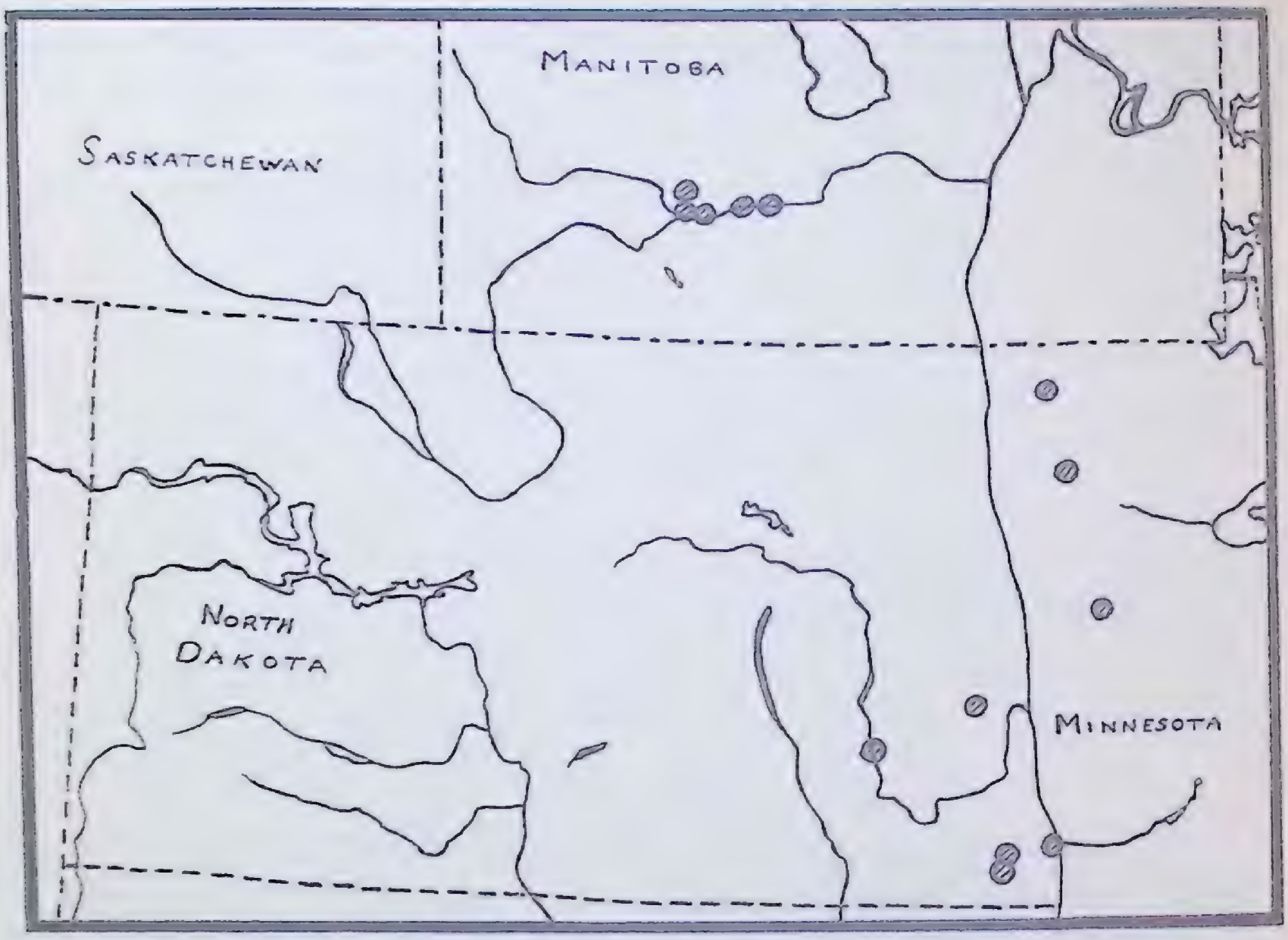


Figure 1. Map showing the location of Manitoba records of *Eumeces septentrionalis* and the nearest Minnesota and North Dakota localities. Records are shown by a hatched circle.

Hales (1919) supplied an additional observation by reporting that on June 15, 1918, he saw a "swift" which he supposed to be *Sceloporus undulatus* at "the big larch swamp about 15 miles east of Brandon." He described the specimen, "about 7 inches long, striped and somewhat bronze in color," and observed it was "rather darker than I have usually seen in what I took to be the same species in the east. I suppose it was *Sceloporus undulatus* or what in Ontario we called the Swift." There is only one species of lizard known to occur in Ontario, the skink, *Eumeces fasciatus* (Logier, 1939; Logier and Toner, 1961). This species is superficially similar to *Eumeces septentrionalis*, and there is little doubt that *Eumeces fasciatus* was the species Hales had seen in Ontario, and *E. septentrionalis* was the species he observed in Manitoba. The specimen was not captured.

Patch (1934) is apparently the first to have identified the Manitoba lizard as *Eumeces septentrionalis*. He examined a specimen taken at "Onah, Manitoba, July 2, 1929. Onah is about twenty miles eastward of Brandon." He quoted a letter from Norman Criddle which accompanied the specimen: "I am sending an example of a swift taken by my brother Talbot at the edge of a larch bog at Onah, Manitoba ... we have taken the species here before and also seen examples along the bank of the Assiniboine river ...." Patch also quoted Hales' (1919) account under this species. It is likely that Hales' report and the Criddle specimen come from near the same larch bog.

Taylor (1935) in his monograph of the genus *Eumeces* cites only one Canadian record, "Onah, Patch (1934)" under *E. septentrionalis*. His map (p. 403, fig. 67) places the record south of the Assiniboine River, in error.

Mills (1948) gives Canadian records of the species as "Range: Manitoba, found at Onak, 20 miles east of Brandon, also a larch swamp near Brandon." Although no references are given in this article, "Onak" is obviously a misprint of "Onah" of Patch (1934), and the Brandon locality is that of Hales (1919) as cited by Patch (1934) with "near" unfortunately substituted for "about fifteen miles east of."

Logier and Toner (1955) gave the species records as "Manitoba. Brandon (Mills, 1949, p. 9) Onah (Patch 1934*b*, p. 51 NMC)." The Brandon locality is from Mills' (1948, *not 1949*) citing of Hales' (1919) report with "near" dropped.

The inclusion of Canada on maps and in statements of range for *Eumeces septentrionalis* in Stejneger and Barbour (1939, 1943), Taylor (1935), Breckenridge (1943, 1944), Smith (1946), Mills (1948), Smith and Slater (1949), Schmidt (1953), Logier and Toner (1955), and Conant (1958) have been based solely on the records of Patch (1934) and Hales (1919). The specimen that Patch received from Norman Criddle and the one Hales observed were from within, at most, five miles of each other and more probably from essentially the same locality.

The most recent reference to Canadian localities for the species is Logier and Toner (1961). The "Brandon" and Onah records are repeated from the 1955 checklist and two additional localities are given, "Cypress River (PC: R. W. Sutton)" and "Treesbank (ROM)." As these are based on existing specimens which have since been examined by the writer, they are discussed below.

## SPECIMENS EXAMINED

An effort was made to borrow all existing specimens of *Eumeces septentrionalis* from Canadian collections. The collections of the Saskatchewan Museum of Natural History, Regina, Saskatchewan; the University of Saskatchewan, Saskatoon, Saskatchewan; the University of Alberta, Edmonton, Alberta (all examined by the author), contain no specimens of this species.

There are ten specimens preserved in collections; these are listed below by museum, with catalogue number, locality, date, collector, and annotations.

MANITOBA MUSEUM (3 specimens)

(1) MM 30R. Sandhills north of Cypress River, 25 August 1946, Rev. A. Champagne.

(2) MM 60. Sandhills on Assiniboine River, north of Cypress River, 28 August 1956, J. Champagne.
(These are the basis for the "Cypress River (PC: R. W. Sutton)" locality of Logier and Toner, 1961.)

(3) MM 63. East of Junction of Assiniboine and Souris rivers, 3 September 1960, R. Sutton and S. Criddle.

UNIVERSITY OF MANITOBA (3 specimens)

(4) ------ Aweme district (Treherne), 20 July 1935, -------.
(Aweme refers to the Criddle farm, five miles north of Treesbank, on the north side of the Assiniboine River. The specimen was likely taken along the river between Aweme and Treesbank. Treherne is a large town to the east, south of the river, probably noted here for ready location of the general area of collection as Aweme is no longer shown on most maps.)

(5) ------ "from Warren Ruth of Sidney" 1 May 1940.
(The wording here seems to indicate that the specimen was not actually from Sidney, which is northeast of Onah. Perhaps the specimen came from Onah or south along the Assiniboine River.)

(6) ------ Treesbank ------ S. Criddle.
(This is probably a specimen collected June, 1958 "on the bank of a sandhill at the edge of the Assiniboine River about a mile below the

junction with the Souris River near the town of Treesbank" and subsequently donated to the University collection. PC: R. D. Bird, 29 September 1960.)

ROYAL ONTARIO MUSEUM (1 specimen)

(7) ROM 9559. Treesbank, received 5 May 1958, S. Criddle.
(Cited by Logier and Toner, 1961. Probably collected from the same area as (6) above.)

NATIONAL MUSEUM OF CANADA (3 specimens)

(8) NMC 1523. Onah, 2 July 1929, Talbot Criddle.
(This is the first Manitoba specimen, reported by Patch, 1934.)

(9) and (10) NMC 4613 (2 specimens). East of junction of Assiniboine and Souris rivers, 23 July 1960, S. Criddle, F. R. Cook, and R. A. Henry.

The maximum total length shown by this series is 178 mm (specimen 4). Total lengths are an unsatisfactory character for comparison, as all specimens but one show evidence of the original tail having been broken off followed by regeneration.

The body lengths (snout-vent) in millimetres were 76 (1), 71 (3), 70 (2), 62 (1), 56 (1), 38 (1), 35 (1). Scale counts, parietals to above anus, were 58 (3) and 59 (7). Scale rows at mid-body were 26 (1), 27 (4), 28 (4), average 27.3, with one specimen on which they could not be counted. Upper labials were 7-7 and supraoculars 4-4 in all specimens. Nine specimens had one pair of nuchals, with a tenth specimen apparently having 1½ pairs.

These measurements and scale counts fit the variation as given by Taylor (1935) for the species throughout its range and by Breckenridge (1943) for Minnesota. Manitoba specimens also agree with these descriptions in colour and pattern. Only the average of 27.3 scales at mid-body is slightly higher than the 26 given by Taylor as usual for northern specimens and the 25.9 average found by Breckenridge for 26 Minnesota specimens. There is a possibility of a slight difference in method which would account for the writer's higher counts.

On the basis of the small sample available from Manitoba it does not appear that this population differs significantly from populations to the south.

The Brandon Normal School had an additional specimen from "near Stockton, on bank of Assiniboine River" taken August 6, 1933, according to the files of the late C. L. Patch. Patch had obtained the specimen on loan, and his notes record its snout-vent length as 72 mm. Mr. Frank Robb, Assistant Secretary-Treasurer of the School District of Brandon No. 129, has informed me (PC: 17 January 1961) that no specimens of this species can be found in the B. J. Hales Natural History Collection, and presumably the specimen has been lost in the many moves that this museum has had during the past twenty years.

## FIELD STUDIES

In July 1960, the writer and R. A. Henry spent two weeks in the Brandon area collecting reptiles and amphibians for the National Museum of Canada. A portion of this time was spent in or near the Spruce Woods Forest Reserve, which lies east of Brandon and includes the Onah area. Unfortunately it was not possible to collect at Onah due to the operations of the Royal School of Artillery in the area. One day, July 23, was spent with Stuart Criddle, along the north side of the Assiniboine River, east of its junction with the Souris River. Two skinks (NMC 4613, cited above) were captured, both from under logs back from the crest of the bank above the river, and a third specimen was seen. No other skinks were found during the period of investigation.

Although most of the field season of July and August 1960 was spent in southwestern and southcentral Manitoba, it yielded no additional observations or reports of skinks outside of the area indicated by existing specimens.

A week during June 1959 was spent by the writer and J. R. Otterdahl in southeastern Saskatchewan, with bases at Moosomin (June 10-12) and Moose Mountain Provincial Park (June 12-16). No reports of skinks were received, and no specimens were seen.

## REPORTS

Skinks were seen several times during the summer of 1959 in the artillery trenches near the now deserted Onah Station (PC: June 1960, J. Clarke and M. G. Foster, Royal Artillery School, Camp Shilo).

Dr. J. A. McLeod, University of Manitoba, has added the following locality (PC: 8 March 1961): "north side of the Assiniboine River about midway between the towns of Austin and Holland on the SE ¼ of 15-9-11 ... one sunny day last September 1960 I noticed a skink clinging to the asphalt siding of cottage sunning itself."

Correspondence with R. W. Sutton, R. D. Bird, and J. A. McLeod has failed to elicit any additional Manitoba localities for the species.

There have been no reports from Saskatchewan.

## STATUS OF MANITOBA POPULATION

The known distribution of *Eumeces septentrionalis* in Manitoba may be summarized from the above records as follows:

ONAH: The sand dunes near the former Onah Station, now deserted, on the C.N.R. main line. Hales, 1919; Criddle, 1919; Patch, 1934 (NMC 1523); PC: Clarke and Foster.

ASSINIBOINE RIVER: The sandy banks and sandhills along the river at four localities:

(1) Just east of junction of Souris and Assiniboine rivers: NMC 63, UM (2 specimens), ROM 9559, NMC 4613 (2 specimens).

(2) North of Stockton. 1 specimen, B. J. Hales collection, Brandon, presumed lost.

(3) North of Cypress River: MM 30R, MM 60.

(4) North of Holland. PC: J. A. McLeod.

The University of Manitoba specimen labelled "from Warren Ruth of Sidney" is not included here as its exact place of collection is in doubt.

As no other localities in Manitoba or Saskatchewan where *Eumeces septentrionalis* has been reported are known, this species may be considered to be relic at the above localities.

All localities are grouped in one general area, within the sandy area of the province, partly encompassed by the Spruce Woods Forest Reserve, east of Brandon. This sand area is thought to have originated as a delta of the Assiniboine River as it flowed into glacial Lake Agassiz (Bird, 1927). It has been of great interest to botanists and has been described in detail by Bird (1927). Bird (1930, 1961) and Scoggan (1953) have also commented on its topography and vegetation.

Wind action has rearranged the dunes and produced a rolling aspect. White spruce, poplar, elm, ash, maple, willow, cottonwood, oak, birch, and larch, the forest cover of the mixed woods and prairie which comprise the dominant vegetation of the area, have been divided into various communities by Bird (1927).

Although the region is remarkable for its southern relic white spruce, the sandy character of the soil rather than any vegetational factor is the most likely reason for the survival of the skinks. The Onah vicinity has a particularly prominent ridge of sand hills, with many patches of exposed sand within the forest cover. The areas along the Assiniboine River are also marked by bare sand areas. Breckenridge (1943, p. 594) has pointed out, based on his observations of *Eumeces septentrionalis* in Minnesota, that "At least in the northern part of its range this skink appears to require a comparatively soft soil allowing it to burrow to a sufficient depth for successful hibernation...."

Bird (1927, p. 209) states: "The soil north of the Assiniboine, save for a shallow surface layer of black humus, is almost pure sand.... South of the Assiniboine the soil is a sandy-clay." It is suggested here that this soil difference may be enough to restrict the distribution of skinks in Manitoba. The pure sand, especially where it occurs in exposed areas, may be the only type of soil in which this species can dig deeply enough to survive the winters at the extreme northern limit of its range.

## NEAREST SOUTHERN POPULATIONS

### Minnesota

Breckenridge (1944, p. 98) shows the northern records from Minnesota as in Kittson, Marshall, and Polk counties. The Kittson County specimen is University of Minnesota No. 1076 collected at Lake Bronson, the Marshall County specimen is Univ. of Minn. No. 1121 without definite locality, and the Polk county specimen No. 1036 is from Fertile (PC: W. J. Breckenridge, 17 January 1961). Dr. Breckenridge further comments that he thinks these specimens were collected "on the sandy beach lines of former Lake Agassiz and not in the fertile heavy soils of the Red River Valley itself. I believe the Lake Bronson colony was situated on what might have been a sandy island in Lake Agassiz formed sometime during its recessional stages and could very well be an isolated population." The Lake Bronson locality is approximately 120 miles east-southeast of the Manitoba records.

### North Dakota

Wheeler (1947, p. 182) gives only two North Dakota records, Lidgerwood and Wahpeton, both of which are in Richland County in the extreme southeastern corner of the state. Since the publication of his paper the following records have been added: Richland County, Danton Tp., Sec. 33; Barnes County, T 138 N R 58W Sec. 10; Cass County, Amenia (PC: G. C. Wheeler, 18 January 1961). These specimens are in the collection of the Department of Biology, University of North Dakota. Dr. Wheeler has kindly supplied the additional information (PC: 31 January 1961) that no skinks were found during collecting for reptiles and amphibians in the northeastern counties of Ramsey, Walsh, Pembina, and Cavalier. In addition, during collecting in the Turtle Mountains area, Bottineau and Rolette counties, and thirty-four years in Grand Forks County he has not found any skinks. The North Dakota records are approximately 200 miles southeast of the nearest Manitoba localities.

Figure 1 shows the Manitoba collections in relation to those from northern Minnesota and North Dakota.

These data add weight to the contention that the Manitoba specimens represent an isolated relic population. Further collecting is needed in southern Manitoba and in northern Minnesota and North Dakota, but on the basis of present records there is no reason for the wholesale inclusion of southern Manitoba, southeastern Saskatchewan, and the large portion of North Dakota, which have been depicted as part of the range of *Eumeces septentrionalis* in Smith (1946), Smith and Slater (1949), and Conant (1958). Correspondence (PC: H. M. Smith, R. Conant) has substantiated that no records for Canada and North Dakota other than those in Logier and Toner (1955) and Wheeler (1947) were known to these writers.

Range maps presented with the supposed known range shaded or zipitoned on the basis of "joining the dots" and extrapolating from a few collections, though standard practice, can only obscure discontinuities where they exist. For this reason maps which show only the localities where a species is known to occur are a more realistic method of portraying the distribution of a species. Although these may be woefully incomplete for the actual range, they encourage collectors to report records that fill in the gaps rather than lead them to erroneously assume that the entire area shown is well documented and that additional records would be superfluous.

If the Manitoba population is relic, the problem of how they reached the Spruce Woods Forest Reserve through an area apparently now uninhabitable for them, remains to be explained. It is suggested that during the warm period between the retreat of the Wisconsin ice-sheet and the present period, the climate may have been sufficiently moderate to allow the skinks to extend in continuous populations between the Minnesota - North Dakota and the Manitoba localities. Subsequent cooling may have eliminated intervening populations which lived on less sandy terrain than that occupied by the surviving Manitoba skinks. In less sandy soil the skinks would be unable to burrow deep enough to survive the colder winters.

Ecological studies are planned which will substantiate or modify these conclusions.

## ACKNOWLEDGMENTS

The writer is indebted to the following: R. W. Sutton, Manitoba Museum; J. A. McLeod, University of Manitoba; E.B.S. Logier, Royal Ontario Museum loaned specimens. R. W. Nero and F. G. Bard, Saskatchewan Museum of Natural History; H. Beck, University of Saskatchewan; V. E. Lewin and R. Lister, University of Alberta, who gave permission to examine collections in their institutions. R. A. Henry and J. R. Otterdahl assisted in field studies in 1960 and 1959 respectively. J. A. McLeod, R. W. Sutton, R. D. Bird, J. Clark, and M. G. Foster provided valuable observations of Manitoba populations. Frank Robb searched for the B. J. Hales Museum specimen. W. J. Breckenridge and G. C. Wheeler provided data on Minnesota and North Dakota skink populations. The former was especially helpful with suggestions on the factors involved in this species' distribution (although the writer assumes responsibility for any errors or misconceptions), and the latter was generous in giving permission for the use of unpublished records. R. Conant and H. M. Smith contributed helpful correspondence.

The writer is particularly indebted to Stuart Criddle, who contributed the original stimulus for this paper and helped immeasurably in finding habitat and specimens in the field.

## SUMMARY

The known records of the Northern Prairie Skink, *Eumeces s. septentrionalis*, in Canada are from Onah in the Spruce Woods Forest Reserve and four localities along the Assiniboine River – just east of its junction with the Souris River, and north of the towns of Stockton, Cypress River, and Holland. The ten specimens from these localities show no differences from the variation described for the species from Minnesota and farther south.

The Manitoba localities are within an area of almost pure sand. It is postulated that this is the factor in the survival of the skinks in this northern area, allowing them to dig deeply enough for safe hibernation. This population is apparently now relic, separated by 120 and 200 miles from the nearest Minnesota and North Dakota populations, respectively. It is suggested that during a warmer post-glacial period the skinks did not have to dig so deeply to ensure survival during hibernation, and they could overwinter in less sandy northern localities. A cooling of the climate would then eradicate all northern populations except those in the sandy area in Manitoba, outlined above.

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QUEEN'S PRINTER AND CONTROLLER OF STATIONERY
OTTAWA, 1964

Cat. no: R95–5/24

Number 25 November 16, 1964

NATIONAL MUSEUM OF CANADA NATURAL HISTORY PAPERS

# Studies of the Byron Bog in Southwestern Ontario XIX. Distribution of Earthworms

W. W. Judd

Department of the Secretary of State

ROGER DUHAMEL, F.R.S.C.
QUEEN'S PRINTER AND CONTROLLER OF STATIONERY
OTTAWA, 1964
Cat. No. NM95-5/25

NATIONAL MUSEUM OF CANADA NATURAL HISTORY PAPERS

# Studies of the Byron Bog in Southwestern Ontario XIX. Distribution of Earthworms

W. W. JUDD

During 1961, studies were undertaken on the non-insect invertebrates of the Byron Bog at London, Ontario, as part of a programme of studies sponsored by the National Museum of Canada. A report on studies of the sowbugs thus collected is given by Judd (1963*a*), and a report on studies of scuds of the genus *Crangonyx* collected in ponds in the bog is given by Judd (1963*b*). The bog and its vegetation zones have been described by Judd (1957).

There are four regions in the bog (Judd, 1957, 1963*a*, 1963*b*): (a) the open bog, (b) a lower, damp wooded region, (c) higher wooded slopes, and (D) the open pond – Redmond's Pond. During 1961 regular daily collections of invertebrates were made from May 8 to September 29 in the four regions. In regions a, b, and c, 250 × 50 ft. plots were marked out with stakes. The location of these plots is shown by Judd (1963*a*, *b*). Each plot in turn was divided into five smaller 50 × 50 ft. subplots, numbered from 1 to 5. On May 8 collections were made in number 1 subplot in regions (a), (b), and (c). Next day, collections were made in number 2 subplot. This procedure was followed on successive days in subplots numbered 3, 4, and 5 and was repeated throughout the summer. This procedure prevented the daily disturbance of the population in any one subplot. Collections in region D, the open pond, were made each day with three sweeps about three yards long through the water with a dip net having a mouth 10 inches in diameter.

Ground-dwelling invertebrates such as earthworms were found by turning over objects on the ground, removing bark from logs, and digging in the soil and moss. Earthworms collected were identified by Dr. G.E. Gates, University of Maine, Orono, Maine. Altogether, 255 worms of seven species[1] were collected. None were collected in the pond (D) or on the floating bog (a). Only six were found in the lower damp wooded region (b). Two of these were juvenile *Allolobophora* sp., and four were microdriles (family Enchytraeidae?). All the remaining 249 specimens were from the dry wooded slopes (c), as follows.

## LUMBRICIDAE

Eiseniella tetraedra (Savigny) – 26 worms, May 10 – August 12. Gates, (1961), Murchie (1956), and Olsen (1928) point out that *E. tetraedra* is

[1] All specimens are deposited in the collection of the National Museum except 4, *A. tuberculata*; 2, *A. turgida*; 2, *D. rubida*; 2, *E. tetraedra*; 16, *L. castaneus*, and 1, *L. terrestris*, kept in the Department of Zoology, University of Western Ontario.

amphibious or occurs in water-soaked banks of lakes and streams. It was not recorded from which part of region (c) the worms were taken in the bog, but most of them were collected before the middle of June when the slopes were damp and puddles were present in the lower areas.

**Eisenia rosea** (Savigny) – 1 worm, May 16. Gates (1961) and Murchie (1956) record this species from a variety of habitats ranging from shores of lakes to forests, fields, and pastures.

**Allolobophora tuberculata** Eisen – 5 worms, May 9, 19, 24, August 19. Gates (1961) records this as a common species in a wide variety of habitats.

**Allolobophora turgida** Eisen – 6 worms, May 13, 16, 29, June 15, 18. Gates (1961) records this species from a wide variety of habitats.

**Lumbricus terrestris** L. – 2 worms, May 10, 11. Gates (1961) records this as an inhabitant of soil containing sand mixed with organic matter.

**Lumbricus castaneus** (Savigny) – 202 worms, May 8 – September 29. This species, the one most commonly collected in the bog, is recorded by Gates (1961) as an inhabitant of leaf litter and humus in woods and leaf piles. Its predominance in region (c) of the bog is in accordance with Gates' report, for on the dry slopes there was a permanent accumulation of rotting leaves and vegetable litter.

**Dendrobaena rubida** (Savigny) – 7 worms, May 9, 26, June 1, 9, 15. Gates (1961) records this species as an inhabitant of sandy loam and black earth.

Gates (1961) puts earthworms in three groups: 1. geophagous – feeding in earth; 2. limiphagous – feeding in mud; 3. litter feeding – litter here including accumulations of any kind of organic matter. The seven species found in the Byron Bog are included by Gates in the three groups as follows:

1. *A. tuberculata, A. turgida, E. rosea, L. terrestris* – 14 worms collected.
2. *E. tetraedra* – 26 worms collected.
3. *D. rubida, L. castaneus* – 209 worms collected.

The distribution of the numbers of worms in these three groups found in the bog correlates well with the extent of the three types of habitat in region (c). Most of the area was covered with leaf litter, decaying vegetation, and humus beneath the trees, thus providing a suitable habitat for *D. rubida* and *L. castaneus*. Mud around the pools and lower slopes in May and June formed a suitable habitat for *E. tetraedra* which was collected mainly during this period, and the other four species collected would be in a suitable habitat in soil beneath the leaf litter and in occasional patches of bare soil on the slopes.

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Number 26 November 16, 1964

NATIONAL MUSEUM OF CANADA NATURAL HISTORY PAPERS

# Studies of the Byron Bog in Southwestern Ontario XXI. Distribution of Centipedes (Chilopoda) and Millipedes (Diplopoda)

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Department of the Secretary of State

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OTTAWA, 1964
Cat. No. NM95-5/26

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# Studies of the Byron Bog in Southwestern Ontario XXI. Distribution of Centipedes (Chilopoda) and Millipedes (Diplopoda)

W.W. JUDD[1]

During 1961 studies were undertaken on the non-insect invertebrates of the Byron Bog at London, Ontario, as part of a programme sponsored by the National Museum of Canada. The Byron Bog and its vegetation zones have been described by Judd (1957).

There are four regions in the bog (Judd, 1957, 1963*a*, 1963*b*: (*a*) the open bog, (*b*) a lower damp wooded region, (*c*) higher wooded slopes, and *(D)* the open pond – Redmond's Pond. During 1961 regular daily collections of invertebrates were made in the four regions from May 8 to September 29. In regions *a*, *b*, and *c*, 250 x 50 ft. plots were marked out with stakes. The location of these plots is shown by Judd (1963*a*, *b*). In turn, each plot was divided into five smaller 50 x 50 ft. subplots, numbered from 1 to 5. On May 8 collections were made in number 1 subplot in regions *a*, *b*, and *c*. Next day, collections were made in number 2 subplot, and on successive days in subplots numbered 3, 4, and 5. This procedure was repeated throughout the summer, and each day disturbance of the population in any one subplot was prevented. Collections in region *D*, the open pond, were made each day with three sweeps about three yards long through the water with a dip net, which had a mouth 10 inches in diameter.

Ground-dwelling invertebrates such as centipedes and millipedes were found by turning over objects on the ground, removing bark from logs, and digging in soil and moss. Centipedes were identified by Dr. R.V. Chamberlin, Department of Biology, University of Utah, Salt Lake City, Utah, and millipedes by Dr. N.B. Causey, Department of Zoology and Physiology, Louisiana State University, Baton Rouge, Louisiana. Mr. M.S. Beverley aided in collecting and sorting specimens during the summer of 1961. Altogether, 8 centipedes and 54 millipedes were obtained. One specimen of each of the four species of millipedes is deposited in the collection of the National Museum, and all others are retained in the collections of the institutions in which they were identified.

## CHILOPODA

All the centipedes were found in region *c*, the wooded slopes, under stones, logs, and the bark of logs and stumps.

[1] Department of Zoology, University of Western Ontario.

**Lithobius forficatus** L. – One each was collected on May 31, June 15, August 2, 8, 12, 14. This is a common centipede in eastern North America (Bollman, 1893) and has been collected at Ottawa (Chamberlin, 1920).

**Sigibius puritanus** Chamberlin – One specimen was collected on August 8. This species is common in New England, and it has been collected at Quebec City (Chamberlin, 1920).

**Lamyctes fulvicornis** Meinert – One specimen was collected on August 11. It is a species which is common in the northern United States (Bollman, 1893).

## Diplopoda

### Polyzoniidae

**Polyzonium bivirgatum** (Wood) – This species was not collected in the bog in 1961 but was found there in a leaf of a pitcher plant in 1956 (Judd, 1957).

All the millipedes collected in 1961 were found in region *b*, the lower damp wooded region, and region c, the upper wooded slopes, under stones, logs, and loose bark of logs and stumps. Three species were found in region c only, and the other was in both regions but predominant in region *b*.

### Julidae

**Ophyiulus pilosus** (Newport) – Thirty specimens were collected in region c on May 8, 9, 13 (3 specimens), May 14, 24, 29 (2 specimens), 31, June 2, 8, July 11 (2 specimens), 29 (2 specimens), 30, August 11 (3 specimens), 14 (2 specimens), 17, September 15, 22 (5 specimens), 29. This species was introduced from Europe and collected in Nova Scotia and Quebec. It is well established in many cultivated areas (Chamberlin and Hoffman, 1958).

**Diploiulus caeruleocinctus** (Wood) – Five specimens were collected in region c on August 13, 19, 28, September 15 and 22. This species, which has been introduced from Europe, is abundant throughout the New England states and is found in Canada (Chamberlin and Hoffman, 1958). It has been collected at Ottawa and Quebec City (Chamberlin, 1920).

### Paraiulidae

**Aniulus bollmani** Causey – Four specimens were collected in region c on May 10, June 23, August 24, 28. This species, which is common in the eastern United States, has been reported from Ontario by Causey (1952).

Aniulus paludicolus Causey (MS) – Eight were collected in region *b* on May 9, 29, June 1, 10, 25, July 15 (2 specimens), September 8. Two were collected in region *c* on May 29 and June 4. Causey describes this species as new and reports it as being confined to sphagnum bogs in southern Ontario, Indiana, Michigan, and Illinois (Causey, pers. comm., Oct. 27, 1961; Mar. 30, 1964). Its presence in region *b* of the bog in larger numbers than in region *c* is in keeping with Causey's report that it is a bog species. Five larvae collected in region *b* on May 20, June 3, 9, July 2, September 29 were reported by Causey (1961) as being in the family Paraiulidae and likely *A. paludicolus*.

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Number 27 November 30, 1964

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NATIONAL MUSEUM OF CANADA **NATURAL HISTORY PAPERS**

# Notes on the Leeches (Hirudinea) of Alberta

J. E. Moore

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# Notes on the Leeches (Hirudinea) of Alberta

J. E. Moore

Although the leech fauna of Alberta has been under investigation for many years, very little information relating to it has appeared in the literature. Moore (1922) reported three species of leeches taken from three widely separated Alberta localities in the early years of this century; Bere (1929) recorded nine species which were collected in 1925 and 1926 during a study of lakes in Jasper National Park; Fredeen and Shemanchuk (1960) have referred to three species obtained in the course of a survey of black fly larvae in the irrigated areas of southern Alberta.

The present paper is based mainly on material obtained by students and other individuals in different parts of Alberta during the summer of 1962 and on that already contained in the University of Alberta hirudinid collection, which was formed by the late Dr. R.B. Miller. The writer identified most of the leeches from these sources and also carried out a special study of the fauna of two ponds, one permanent and the other temporary, in the Edmonton area. Data from the publications mentioned above and also for Alberta specimens in the University of Saskatchewan collection have been included as well.

As a result of the studies of Alberta leeches a total of 16 species have been identified, and among these are representatives of all orders and families of North American freshwater Hirudinea. The following is a list of the species arranged according to the system of classification given by Moore (1959):

Order Rhynchobdellida
  Family Glossiphoniidae
Genus *Glossiphonia* Johnson 1816
  *Glossiphonia complanata* (Linnaeus) 1758
Genus *Helobdella* E. Blanchard
  *Helobdella stagnalis* (Linnaeus) 1758
Genus *Oculobdella* Autrum 1936
  *Oculobdella lucida* Meyer and Moore 1954
Genus *Placobdella* Blanchard 1896
  *Placobdella ornata* (Verrill) 1872
  *P. papillifera* (Verrill) 1872
  *P. parasitica* (Say) 1824
Genus *Theromyzon* Philippi 1884
  *Theromyzon meyeri* (Livahow) 1902
  *T. rude* (Baird) 1863

Order Rhynchobdellida cont'd
Family Piscicolidae
Genus *Illinobdella* Meyer 1940
*Illinobdella moorei* Meyer 1940
Genus *Piscicola* Blainville 1818
*Piscicola milneri* (Verrill) 1771
Order Gnathobdellida
Family Hirudidae
Genus *Haemopis* Savigny 1820
*Haemopis grandis* (Verrill) 1874
*H. marmorata* (Say) 1824
Order Pharyngobdellida
Family Erpobdellidae
Genus *Dina* E. Blanchard
*Dina parva* Moore 1912
Genus *Erpobdella* Blainville 1818
*Erpobdella punctata* (Leidy) 1870
Genus *Mooreobdella* Pawlowski 1955
*Mooreobdella fervida* (Verrill) 1874
Genus *Nephelopsis* Verrill 1872
*Nephelopsis obscura* Verrill 1872

In the notes which follow, the details of distributions and some data on reproduction, feeding habits, and other features of Alberta leeches are presented.

*Glossiphonia complanata* occurred in Amisk Creek, Astotin L., Blackmud Creek, Cold L., Crimson L., Cutbank L., Ghostpine L., Hastings L., Henderson L. (Lethbridge), Kehiwin L., Long Island L., Wabamun L., two beaver ponds near the Alberta Biological Station at Gorge Creek, and in a pond near Edmonton. Bere (1929) has reported this species from Beauvert L., Big Trefoil L., Iris L., Maligne L., Marjorie L., an unnamed lake north of Geikie, Caledonia and Pyramid creeks, outlet of Lake Beauvert in Jasper National Park. On the basis of these records *G. complanata* may be regarded as widely distributed in Alberta. Also, since it has been reported from eight of the provinces and from the Northwest Territories (Meyer and Moore, 1954), this leech is obviously widespread in Canada.

Adults carrying young were collected on June 10, 1953, at Kehiwin Lake; on June 5, 1962, in a beaver pond near the Alberta Biological Station; and in July, 1962, from Amisk Creek. It would appear that in this area the breeding period is in late spring and early summer.

Specimens of *G. complanata* from a pond near Edmonton were retained in an aquarium in order to observe something of their food habits. Snails from the same pond were introduced, and it was noted that the leeches fed on *Physa heterostropha* and *Menetus exacuous* but did not touch small specimens of *Lymnaea emarginata*. In most instances a feeding extended through

an interval of two to four hours, during which time the entire soft parts of the snail were consumed.

The coloration of our specimens, although subject to considerable variability, was usually light green, light brown, or greenish brown. The stripes on the venter were quite constant, but occasionally those on the dorsal surface did not extend to the posterior end of the body, as was generally the case. In all instances the arrangement of the three pairs of eyes followed the typical pattern for this species.

*Helobdella stagnalis* was taken at Amisk Creek, Astotin L., Hastings L., Henderson L., Kehiwin L., Square L., Wabamun L., Waterton L., and from a pond near Edmonton. It has been reported also from Big Trefoil L., Caledonia L., Marjorie L., Pyramid L., an unnamed lake north of Geikie, and Pyramid Creek in Jasper National Park by Bere (1929). In addition, the writer has examined two specimens of this species collected by Fredeen and Shemanchuk (1960) in an irrigation canal northeast of Seven Persons. Because of inconspicuous coloration and small size, it seems likely that *H. stagnalis* could be overlooked very easily during collecting activities, and undoubtedly it has a much wider distribution than our records indicate. The presence of *H. stagnalis* in the area immediately north of Alberta is revealed by a specimen obtained on August 12, 1962, from a pond near Lady Evelyn Falls on the Kakisa River, and by the Great Slave Lake records of Moore and Meyer (1951). From the data of Meyer and Moore (1954) and Oliver (1958) it is evident that this species, like *G. complanata*, is of widespread occurrence in Canada.

Four specimens of H. *stagnalis* collected in Henderson Lake on May 16, 1962, were carrying either eggs or recently hatched young. Further data on the breeding habits of this leech were obtained from a study of collections made in a permanent pond near Edmonton during the spring, summer, and autumn of 1962. All ten individuals taken on May 24 had either eggs or young attached; one specimen found on May 27 showed the presence of young; each of nine leeches collected on June 2 was carrying young; adults taken June 21 and July 7 exhibited no indication of attached eggs or young. Subsequent observations disclosed the following information: July 23 – out of seven individuals, one had eggs and another had young attached; July 27 – two of the three specimens collected were carrying eggs; August 2 – two out of nine *H. stagnalis* had young, and in one case there were only six large young, of which three left the parent shortly after collection; August 7 – three of the seven specimens had young attached; August 10 – two out of five were carrying young; August 16 – only one individual, which bore young, was found; August 30 – 11 specimens were collected, none showing evidence of young; September 6 – the single individual taken was carrying young; September 13 – five adults were found, none having young; 50 specimens collected between October 2 and November 9 were in non-breeding condition. Thus it is evident that in this particular pond there are two periods of reproduction during a single year. The same phenomenon has

been reported also for England (Mann, 1962) and Minnesota (Moore, 1912). Furthermore, it seems apparent that all the *H. stagnalis* which survive the winter breed in the spring. Finally, it is evident that only a portion of the population existing during the summer takes part in the second reproductive cycle of the year. Such conclusions are in agreement with those for *H. stagnalis* in England, as presented in Mann's comprehensive treatise on leeches (1962).

*H. stagnalis* is reported to feed on small annelids, insect larvae, snails, and the like (Moore, 1912). In one of our feeding experiments this species consumed the soft parts of *Menetus exacuous* but did not touch *Helisoma trivolvis, Lymnaea emarginata* or *Physa heterostropha*.

*Oculobdella lucida* was found in Astotin Lake, Square Lake, in a pond near the Alberta Biological Station, in a slough near Irvine, and in one permanent and one temporary pond near Edmonton (see fig. 1). The specific determination has been confirmed by Dr. M.C. Meyer.

This species was named and described by Meyer and Moore (1954; 68–80) from specimens collected in Whitewater Lake near Deloraine, Manitoba. and until now has not been reported from any additional localities. On the basis of our records it appears that *O. lucida* inhabits the smaller, shallower bodies of water, and this leech may well be a common inhabitant of the numerous temporary and permanent ponds known locally as sloughs.

Our observations on *O. lucida* have provided a substantial body of knowledge which supplements that presented by Meyer and Moore (1954), and it seems desirable to indicate in some detail what has been learned of the life history and habits in the temporary and permanent ponds near Edmonton. The temporary pond when first examined on May 8, 1962, was approximately 80 m long and 8 m wide with a maximum depth of 0.7 m. Numerous specimens of *O. lucida* were present under boards at the edge of the pond. For the most part, these were light brown in colour although some individuals had a rather dusky appearance. In the majority, the length at rest was about 10 mm, but the body was capable of extending to 25 mm. On May 14 some specimens had eggs attached to the venter, and this condition was general on May 15 with a water temperature of 22°C and pH of 7.0-7.5. In most instances the eggs were contained in six capsules, but one individual was carrying seven and another eight. There was considerable variation in the number of eggs (7-52) contained in the different capsules, but usually the most anterior pair held the smallest numbers. The total number of eggs, as revealed by counts for 14 individuals, ranged from 71-222, while the average was 156. Specimens with eggs attached were collected on May 26 and retained in aquaria where it was observed that these leeches performed respiratory movements which were somewhat more vigorous than in the case of individuals which did not carry eggs. On May 28 it was noted that the eggs had hatched and that all specimens were carrying young. Collecting at the pond on May 30 yielded six *O. lucida*, of which five bore young while the remaining leech still retained its egg capsules. An

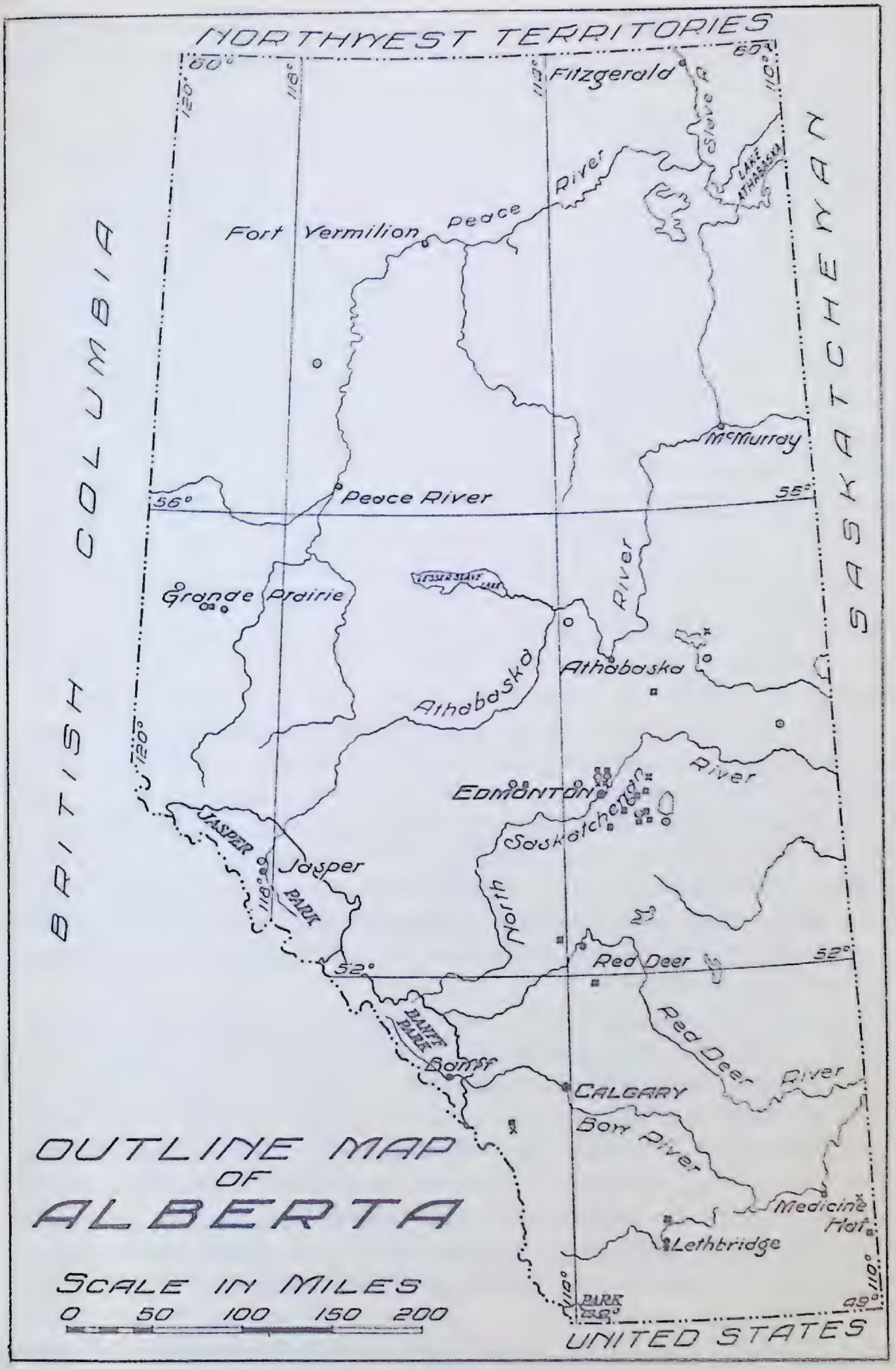


Fig. 1. Records of *Oculobdella lucida* (x), *Placobdella ornata* (⊙) and *Theromyzon rude* (■) in Alberta.

examination of this pond on July 10 showed that small (about 5 mm), independent leeches were very abundant and that considerable numbers of larger individuals (12-15 mm) were also in evidence.

On August 10 (temperature 27°C and pH 7.0) there were 10-mm leeches bearing eggs and a few larger specimens carrying young. The larger individuals were either light or dark brown in colour or else had dark blotches on a light brown background, and one of the smaller leeches also showed a blotched pattern. By August 22 the pond had receded to an area of approximately 2 $m^2$, and the depth was 7 cm. The temperature on this date was 13°C and the pH 6.5. Large, medium, and small individuals were collected, and young were attached to all the large leeches, whereas representatives of the other two size-groups were carrying either eggs or young. Collections on August 23 and 24, when the pond had almost disappeared, yielded 6 large specimens of which one had young attached, 20 leeches of medium size, 40 small individuals, and 10 newly released young. There was no water remaining on August 25, but a single small specimen was found in moist debris beneath a stone. These observations seem to indicate that small individuals which survived the winter produced young early in the spring and then grew to full size and gave rise to a second crop of young in late summer and also that the young produced in the spring were capable of breeding later in the year. However, it is obvious that further studies are required in order to elucidate the pattern of reproduction in the temporary ponds of this area.

Specimens of *O. lucida* were taken from the permanent pond (some 30 acres in area) at approximately weekly intervals from May 27 until November 9. On nearly all occasions between June 2 and September 25 large individuals (15 mm or more at rest) and also those of medium size (about 12 mm) were carrying eggs or young. On October 2 one medium and three small (10 mm) specimens were bearing young, and on October 9 one large *O. lucida* had a single young attached. Only individuals of small and medium sizes were collected on October 25, November 2, and November 9; none showed evidence of eggs or young.

In this particular habitat, breeding individuals varied in size from 10 x 2.5 mm at rest (20 x 2 mm extended) to 20 x 10 mm (45 x 6 extended). Large specimens with young attached were kept in aquaria on several occasions, and it was noted that when the young left the parent they were 5-6 mm long and could extend to a maximum of 12-15 mm. Further, it was noted that large individuals bearing young fed actively until such time as the young departed and died a day or two thereafter. It is suspected that most, or perhaps all, of the large representatives of this species in a permanent pond die after reproducing. Whether the same applies to small or medium-sized individuals is not known.

During the course of our observations it became apparent that snails constitute one of the main food sources for *O. lucida*. On various occasions this species was seen to feed on *Physa heterostropha*, *Menetus exacuous*, and also on *Lymnaea emarginata* of small size. However, when *O. lucida*

was segregated and supplied with all three types of snails there was a definite preference for *P. heterostropha*.

In order to learn something of the food intake of *O. lucida*, two large specimens (bearing young) were put in separate aquaria on September 14 and supplied with one of each of the three species of snails referred to above. Whenever a snail had been eaten, it was replaced by another of the same kind. One of the leeches died on September 29, shortly after the last of its progeny had left it. During the time of observation it had removed the complete soft parts of seven *P. heterostropha*. The other individual lived until the evening of October 3—the last of its young having departed during the day. A total of nine *P. heterostropha* were consumed by this specimen. Thus it appears that approximately one *P. heterostropha* every two days is sufficient to satisfy the food requirements of large specimens of *O. lucida* which are carrying young. In another set of experiments it was observed that during a five-day period one *O. lucida* of medium size ate four *P. heterostropha* while a large individual consumed five of these snails in the same interval. Neither of these leeches showed evidence of young. From repeated observations it became apparent that a large individual takes a maximum of four hours to complete a feeding but may finish its meal in as little as two hours.

*Placobdella ornata* occurred in collections from Amisk Creek, Big Island L., Cooking L., Cutbank L., Fish L. near Hythe, Hondo L., Isle L., Kehiwin L., Twin L., and from a permanent pond and a temporary pond near Edmonton. A single specimen of *P. ornata*, partly distended with blood, was found among the feathers of a horned grebe (*Podiceps auritus*) taken from a slough near Muir Lake, north of Spruce Grove, by Mr. J.R. Gallimore. This species, reported as *P. rugosa*, has been collected in Pyramid Lake, Jasper National Park (Bere, 1929) and "near Beaver Lake" (Moore, 1922). From these records it is apparent that *P. ornata* is widely distributed in central Alberta (fig. 1). Records of this species in an area of the Northwest Territories adjacent to the Province of Alberta included the following: McNiven Beach at Yellowknife, a lake 36 mi. west of Yellowknife, a pond 37 mi. west of Enterprise, and a lake 75 mi. west of Enterprise. Since *P. ornata* has been recorded also from Manitoba, Ontario, Quebec, and Nova Scotia (Meyer and Moore, 1954), it appears to be the most widely distributed species of the genus *Placobdella* in Canada.

A specimen from Fish Lake taken on August 14, 1954, had young attached, and a 63-mm individual collected in the pond west of Enterprise on August 7, 1962, was carrying 95 young. On the basis of these data it appears that *P. ornata* in this area has its breeding season during the summer months. Our only positive information on feeding habits comes from the partly engorged specimen which was found on the grebe mentioned above. During an experiment lasting two weeks, small individuals of this species did not feed on snails (*P. heterostropha* and *M. exacuous*).

*Placobdella papiHifera* was present in a sample of leeches taken from Amisk Creek in July 1962. Just one specimen was obtained, and this has been identified by Dr. M.C. Meyer. As far as the writer is aware, the only previous record of this species in Canada is that for Whitewater Lake, Manitoba, given by Meyer and Moore (1954).

*Placobdella parasitica* was represented by a single individual with young taken from Lake Minnewanka, Banff National Park, on August 1, 1936. This specimen which forms part of the University of Saskatchewan collection was identified by Dr. R.J. Myers.

*Theromyzon meyeri* has not been reported for Alberta under this name, but there are records of the synonymous species *T. occidentalis* and *Hemiclepsis occidentalis*. Bere (1929) identified *T. occidentalis* from Little Trefoil, Maligne, Marjorie, and Talbot lakes in Jasper Park. Fredeen and Shemanchuk (1960) have mentioned the presence of *T. occidentalis* in the irrigated area of southern Alberta – one of their specimens was taken from a canal near Seven Persons. In the University of Saskatchewan collection there is a single individual, determined by Dr. R.J. Myers as *Hemiclepsis occidentalis*, which was found in Skee (Kesler) Lake, Waterton National Park, on August 27, 1937.

Inasmuch as there has been considerable confusion with respect to the species of the genus *Theromyzon*, which are represented in the North American fauna, it seems not unlikely that at least some of the records indicated above for *T. meyeri* actually refer to leeches now designated as *T. rude*.

*Theromyzon rude* was present in collections from Cooking L., Cutbank L., Davey L., Grayburn Creek, Hastings L., Henderson L. (Lethbridge), Long L. (east of Alpen), Sylvan L., Wabamun L., a beaver pond near the Alberta Biological Station, and in a permanent pond and a temporary pond near Edmonton. This species was taken also at five localities in the neighbouring part of the Northwest Territories as follows: McNiven Beach at Yellowknife, a lake 36 mi. west of Yellowknife, Caen Lake about 40 mi. south of Yellowknife, a pond 37 mi. west of Enterprise, and a pond near Lady Evelyn Falls on the Kakisa River.

In a study carried out by Mr. J.R. Gallimore in Alberta during the summer of 1962, a number of specimens belonging to the genus *Theromyzon* were taken from the nasal passages of four kinds of grebe. Some of these leeches were so small or so distended with blood that specific identification was impossible, but those indicated below were determined as *T. rude*. One or two specimens occurred in each of four Horned Grebes (*Podiceps auritus*) collected from ponds near Leduc and Uncas and from a reservoir near Picture Butte. Two small individuals came from a Pied-billed Grebe (*Podilymbus podiceps*) taken from a pond about 9 mi. southeast of Bremner. Two Red-necked Grebes (*Podiceps grisegena*) from Big Island Lake each contained two small or medium-sized leeches. Two Eared Grebes (*Podiceps nigricollis*) from Big Island Lake and one from a pond near the same lake

each harboured a single *T. rude* of small or medium size. The very small or greatly distended specimens of *Theromyzon* occurred in two Red-necked Grebes and one Eared Grebe from Big Island Lake and in three Eared Grebes from a reservoir near Coaldale. From the records presented it is apparent that *T. rude* is widespread in the lakes and ponds of Alberta (fig. 1) and that it infests at least some types of water birds in this area. In the latter connection, it is of interest to note that *T. rude* has been reported from the nares, buccal cavity, and the body surface of three species of duck from Whitewater Lake, Manitoba, by Meyer and Moore (1954). These authors suggest the possibility that this leech may be a cause of death among waterfowl, especially young birds. They point out that the allied species *T. tessulatum* is known to be a serious parasite of ducks and geese in Denmark and of ducklings in England. The University of Alberta collection contains one specimen of *T. rude* taken from the nostril of a Mallard (*Anas platyrhynchos*), but we have no further data on occurrence in Alberta ducks.

Specimens of *T. rude* with young attached were collected at Cutbank Lake on August 13, 1954; Long Lake in June 1962; Sylvan Lake on July 30, 1956; a beaver pond near the Alberta Biological Station on July 28, 1962; and from a permanent pond near Edmonton on July 23, 1962. In the last instance there were only two young involved, and in both, the digestive tract was filled with blood. Additional information on reproduction in this species is provided by a leech taken on August 5, 1962, from a pond near Lady Evelyn Falls on the Kakisa River, Northwest Territories; this individual was carrying 234 young.

*Illinobdella moorei* was found on walleyes (*Stizostedion vitreum*) taken from the Bow River below the dam at Bassano on February 10, 1961. The specific determination was made by Dr. M.C. Meyer. *I. moorei* has been recorded also for Saskatchewan and Ontario in the paper on Canadian leeches by Meyer and Moore (1954).

*Piscicola milneri* has been collected at Cold L., Wabamun L., and Waterton L. The specimens from Wabamun Lake were attached to the fins of the common sucker (*Catostomus commersoni*). The Waterton Lake representatives, which were found on June 20, 1937, form part of the University of Saskatchewan collection; these were identified by Dr. J.P. Moore. This piscicolid has been reported also from the Northwest Territories, Ontario, and Quebec by Meyer and Moore (1954), and from Saskatchewan by Oliver (1958).

*Haemopis grandis* was not encountered during the present investigation, but it has been reported from Beauvert, Caledonia, Hibernia, and Patricia lakes in Jasper National Park (Bere, 1929). Present information indicates that in Alberta this species occurs only in the mountainous region, but more extensive collecting could reveal a distribution which includes other areas of the Province. *H. grandis* has been found also in northern Saskatchewan (Oliver, 1958) and in Manitoba, Ontario, Quebec, New Brunswick, and Prince Edward Island (Meyer and Moore, 1954).

*Haemopis marmorata* occurred in Cold L., Cottage L., Crimson L., Hondo L., Isle L., and Kehiwin L. It has been reported also from Beauvert L., Big Trefoil L., Caledonia L., Hibernia L., Little Trefoil L., Marjorie L., and a lake north of Geikie in Jasper National Park (Bere, 1929) and from "Vermillion Lakes," Banff National Park, and "near Beaver Lake" (Moore, 1922). A single individual of this species was collected in a pond 62 mi. west of Enterprise, Northwest Territories. It is evident that *H. marmorata* is widespread in the mountains and in the central portion of Alberta. Meyer and Moore (1954) have mentioned the occurrence of this species in all the major areas of Canada except Newfoundland and the Yukon Territory.

The colour pattern of our specimens of *H. marmorata* showed considerable variation. Generally the dorsal surface was a dark shade of green and exhibited numerous black blotches, but in some cases these were almost absent. The ventral surface was usually lighter in colour and less spotted than the dorsal, although it too presented a wide range in the degree of spotting. There was some variability in the location of the genital apertures—these were located in the anterior portions of the annuli bearing them, or else they were strictly in between the annuli.

The members of the genus *Haemopis* are generally of much greater size than other types of leeches occurring in Alberta. Our largest specimen is one from Isle Lake which has measurements of 122 x 20 mm in the extended condition.

A single *H. marmorata* collected at Cottage Lake on October 18, 1956, showed the presence of numerous metacercariae in the body wall.

*Erpobdella punctata* was taken in Amisk Creek, Blackmud Creek (south of Edmonton), Big Island L., Cold L., Cottage L., Crimson L., Cutbank L., Henderson L., Isle L., Kehiwin L., Sylvan L., Wabamun L., and in a permanent pond near Edmonton. It has been found also at McNiven Beach, Yellowknife, Northwest Territories. Bere (1929) reported this species from the following localities in Jasper National Park: Annette L., Caledonia L., Dorothy L., Edith L., Marjorie L., Mildred L., Patricia L., Pyramid L., an unnamed lake north of Geikie, and Pyramid Creek. Judging from present evidence of occurrence, it would appear that this is one of the most common leeches in the Province. It has been reported also from most other regions of Canada (see Meyer and Moore, 1954).

Some representatives of this species from Big Island L., Isle L., and the pond near Edmonton were seen to be spotted with white cysts. Dr. J.C. Holmes has examined such specimens and has identified the cysts as those of metacercariae of strigeid trematodes. In the permanent pond near Edmonton, approximately one half of all (42) the adult *E. punctata* collected between May 8 and November 9, as well as all the young individuals (40) found from October 2 to November 9, were parasitized.

Very small specimens of *E. punctata* were noticed in the permanent pond near Edmonton on June 23, 1962, and were found from time to time until October 2. These were pinkish grey in colour and about 8 mm in length.

Somewhat larger, but still young, individuals were collected on several occasions up until November 9. It was observed that with increasing size the coloration changed from light brown (15 mm) to dark brown (20-25 mm). The colour of large members of this species (up to 70 mm extended) was usually an olive green or sometimes dark brown with two or, more often, four longitudinal rows of black spots on the dorsum. One leech was peculiar in that it possessed two pairs of labial eyes on the right and three labial eyes on the left instead of the customary pair on each side.

*Dina parva* was represented by two specimens from Grayburn Creek in the Cypress Hills and one from Lake Minnewanka, Banff National Park. This species has been reported also by Bere (1929) from Maligne Lake and from a beaver pond near Medicine Lake in Jasper National Park. The *D. parva* from Lake Minnewanka is in the University of Saskatchewan collection and was determined by Dr. R.J. Myers. Meyer and Moore (1954) have mentioned the occurrence of this species in Ontario and Quebec, and Oliver (1958) has recorded it from seven localities in Saskatchewan.

*Mooreobdella fervida* – A single representative of this species from Lees Lake near the Crowsnest Pass has been identified by Dr. J.P. Moore under the former name of *Dina fervida*. This individual, which was collected on August 17, 1937, is part of the University of Saskatchewan collection. Fredeen and Shemanchuk (1960) have referred to the presence of leeches, tentatively determined as *M. fervida*, in irrigation waters of southern Alberta. The specimens in question were obtained from canals near Seven Persons and Taber. This species has been reported also from five of the eastern provinces by Meyer and Moore (1954) and from two lakes in Saskatchewan (Oliver, 1958).

*Nephelopsis obscura* was collected in Amisk Creek, Astotin L., Bella L., Big Island L., Blackmud Creek, Cairns L., Chickakoo L., Cold L., Cottage L., Cox L., Crimson L., Cutbank L., Davey L., Gould's L., Hastings L., Kehiwin L., Long L. near Alpen, Lower Kananaskis L., Square L., South Two L. (100 mi. south of Grande Prairie), Summit L., Waterton National Park, Sylvan L., Twin L., Wabamun L., a dam near Medicine Hat, a beaver pond near the Alberta Biological Station, a pond 30 mi. southwest of Calgary, ponds near Beaverlodge, Edmonton, and Ellerslie, and in a water reservoir near Lethbridge. This species has been recorded by Bere (1929) from Annette L., Beauvert L., Big Trefoil L., Dorothy L., Edith L., Hibernia L., Marjorie L., Mildred L., Patricia L., Pyramid L., an unnamed lake north of Geikie, and from Caledonia Creek in Jasper National Park. *N. obscura* was found also at two points in the Northwest Territories: McNiven Beach, Yellowknife, and a pond near Lady Evelyn Falls on the Kakisa River. This species showed the widest distribution of all Alberta leeches, and Meyer and Moore (1954) reported it from most of the major sections of the Dominion.

Young individuals were taken at various localities from May 5 to August 25 in different years. In the permanent pond near Edmonton they were

encountered for the first time on September 13 and were collected also on September 25, October 2, 17, and 25, and on November 2, 1962. Out of a total of 11 young specimens. three were infected by parasites which have been determined by Dr. J.C. Holmes as metacercariae of strigeid trematodes.

The colour of our specimens of *N. obscura* was usually grey or grey-green with numerous black blotches on the dorsum, but the venter was plain. In some individuals the dark spots were few in number and were widely separated whereas in others they were so plentiful that the dorsal surface appeared almost black. An over-all dark coloration was characteristic of the *N. obscura* from Blackmud Creek. Wide differences in colour patterns have been reported also for the Jasper Park collections of this species by Bere (1929), who recognized four main types. Single individuals from Big Island Lake and a pond near Ellerslie and three specimens from the permanent pond near Edmonton were peculiar in that they possessed only three labial eyes instead of the usual two pairs. *N. obscura* proved to be one of the larger leeches in our collections, and some adults had a length of 100 mm when the body was extended.

## DISCUSSION

Sixteen species of leeches have been recorded for Alberta, and five of them (*Glossiphonia complanata, Helobdella stagnalis, Theromyzon rude, Erpobdella punctata,* and *Nephelopsis obscura*) may be regarded as widely distributed in the central and southern portions of the Province. More extensive collecting might well reveal a similar condition in the case of some other forms, e.g., *Haemopis marmorata, Oculobdella lucida, Piscicola milneri,* and *Placobdella ornata.* The majority of our species have been reported from other parts of Canada, and the ranges of a few of them, such as *G. complanata, H. stagnalis, H. marmorata, E. punctata,* and *N. obscura,* are included in almost all the major areas of the Dominion (Meyer and Moore, 1954). *O. lucida,* which has not been found outside of Manitoba and Alberta, may be confined to the region of central Canada. The range of *T. rude* is of special interest since it comprises the Northwest Territories, the Prairie Provinces of Canada, and the northern United States along the Rocky Mountain duck flyway (see Meyer and Moore, 1954).

All the species except *O. lucida* occur in the United States (Bere, 1931; Meyer, 1946; Moore, 1912, 1952), and *G. complanata* and *H. stagnalis* occur as well in Europe (Mann, 1962). Thus, it is apparent that the leech fauna of Alberta consists of some species which occur both in Europe and North America, others which are distributed widely over the North American continent, still others which are of more limited occurrence on this continent, and finally one species which may be restricted to the Prairie Provinces of Canada.

This communication includes records for 79 localities (51 lakes, 20 ponds and reservoirs, 8 streams), most of which are situated in the central

and southern portions of Alberta. Very few collections have been obtained as yet from the vast number of aquatic habitats in northern Alberta. However, since *G. complanata, H. stagnalis, P. ornata, T. rude, P. milneri, H. marmorata, E. punctata,* and *N. obscura* have been found in an area of the Northwest Territories immediately north of Alberta, these species can be expected to occur in the northern part of the Province. Also, it seems likely that some forms such as *Mooreobdella fervida* and perhaps *Dina parva* and *Haemopis grandis* reach northern limits of distribution within Alberta.

It is of interest to indicate how the number of species (16) found in Alberta compares with the numbers reported for other large areas in North America. Twenty-seven species have been recorded for Ontario (Meyer and Moore, 1954), 21 for Minnesota (Moore, 1912), 20 for Saskatchewan (Oliver, 1958), 18 for northeastern Wisconsin (Bere, 1931), and 14 for Illinois (Moore, 1898). Further investigations in Alberta will undoubtedly lead to an increase in the list presented in this paper, but we do not anticipate that many additional species will be encountered. *Dina dubia,* which has been reported from Great Slave Lake, Northwest Territories (Moore and Meyer, 1951) and from two localities in Saskatchewan (Oliver, 1958), and *Placobdella montifera,* which has been found in British Columbia and Ontario (Meyer and Moore, 1954) and also in Saskatchewan (Oliver, 1958), may be mentioned as species with a distribution that might include some Alberta localities.

## ACKNOWLEDGMENTS

The writer wishes to thank Dr. G.O. Mackie and various students of the Department of Zoology, University of Alberta, for their valuable assistance during the course of this survey. Thanks are extended also to Dr. M.C. Meyer of the University of Maine for identifying a number of species of leeches, to Dr. A.H. Clarke of the National Museum of Canada for determining the mollusks, and to Dr. J.C. Holmes of the Department of Zoology, University of Alberta, for identification of the leech parasites. Permission to use the data for Alberta material in the University of Saskatchewan collection was granted by Dr. U.T. Hammer. This study was carried out under a grant kindly provided by the National Museum of Canada.

## KEY TO THE SPECIES

1 Mouth a small pore in the oral sucker through which a muscular proboscis may be protruded; jaws absent ..... Order RHYNCHOBDELLIDA 3
– Mouth large occupying entire cavity of oral sucker; no proboscis ..... 2
2 Eyes 5 pairs forming lateral arches on II to VI; jaws present or absent ..... Order GNATHOBDELLIDA
Family HIRUDIDAE 11
– Eyes 3 or 4 pairs in separate labial and buccal groups; jaws absent ..... Order PHARYNGOBDELLIDA
Family ERPOBDELLIDAE 12
3 Body at rest usually flattened and not divided into distinct anterior and posterior regions; head sucker not distinctly marked off from body; 3 annuli per segment in the mid-body region ..... Family GLOSSIPHONIIDAE 4
– Body at rest cylindrical and usually divided into distinct anterior and posterior regions; 14 annuli per segment in the mid-body region ..... Family PISCICOLIDAE 10
4 Eyes 1 or more pairs well separated ..... 5
– Eyes 1 pair close together or apparently united ..... 9
5 Eyes 1 pair ..... 6
– Eyes 3 or 4 pairs ..... 7
6 Gonopores separated by 1 annulus; last crop caeca strongly reflexed; horny scute on dorsum of annulus 12 ..... *Helobdella stagnalis*
– Gonopores united; last crop caeca slightly or not at all reflexed; no horny scute ..... *Oculobdella lucida*
7 Eyes 3 pairs ..... *Glossiphonia complanata*
– Eyes 4 pairs ..... 8
8 Gonopores separated by 2 annuli ..... *Theromyzon meyeri*
– Gonopores separated by 3 annuli ..... *T. rude*
9 With large rough dorsal tubercles and numerous smaller ones; colour pattern a fine mixture with a median dorsal light stripe interrupted by short brown longitudinal lines; venter unstriped ..... *Placobdella ornata*
– With small but numerous dorsal tubercles; dorsum with longitudinal brown stripes; venter unstriped ..... *P. papillifera*
– With dorsal tubercles inconspicuous or absent; bold pattern of brown, green, and yellow on dorsum; venter with bluish stripes ..... *P. parasitica*
10 Pulsatile vesicles on sides of body; suckers distinctly marked off from body ..... *Piscicola milneri*
– No pulsatile vesicles; suckers not distinctly marked off from body ..... *Illinobdella moorei*
11 3rd annulus of VII and 1st of VIII enlarged but only faintly or not at all divided; jaws and teeth present, teeth 12-16 pairs ..... *Haemopis marmorata*
– 3rd annulus of VII and 1st of VIII enlarged and subdivided; jaws and teeth absent ..... *H. grandis*
12 Annulus b6 not obviously enlarged or subdivided; eyes 3 pairs; 2 or 4 longitudinal rows of black spots on dorsum ..... *Erpobdella punctata*
– Annulus b6 obviously enlarged and subdivided; eyes 4 pairs (except in some *M. fervida* which have 3 pairs); no longitudinal rows of spots on dorsum ..... 13
13 Gonopores separated by 3 to 3½ annuli ..... *Dina parva*
– Gonopores separated by 2 annuli ..... 14
14 Vas deferens with a long preatrial loop; usually with irregular blotches on dorsum ..... *Nephelopsis obscura*
Vas deferens without preatrial loop; colour in life pale red ..... *Mooreobdella fervida*

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Number 28 Jan. 8, 1965

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# Studies of the Byron Bog in Southwestern Ontario XVIII. Distribution of Harvestmen and Spiders in the Bog

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Department of the Secretary of State

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# Studies of the Byron Bog in Southwestern Ontario XVIII. Distribution of Harvestmen and Spiders in the Bog

W.W. JUDD

The Byron Bog has been described by Judd (1957). In 1961 studies of the non-insect invertebrates in the bog were undertaken by the Department of Zoology, University of Western Ontario, in cooperation with the National Museum of Canada. The first report on these studies concerns sowbugs (Judd, 1963) and includes a map of the bog and a description of collecting sites and methods. Harvestmen and spiders were also collected, and the present report concerns these collections.

There are four regions in the bog (see map, Judd, 1963): (a) the open floating bog, (b) a lower damp wooded region, (c) higher wooded slopes, and (D) the open pond, Redmond's Pond. During 1961 regular daily collections of invertebrates were made from May 8 to September 29 in the four regions. In regions a, b, and c, 250 by 50–foot plots were marked out with stakes. Each plot in turn was divided into five smaller 50 by 50–foot subplots, numbered from 1 to 5. On May 8 collections were made in number 1 subplot in regions a, b, and c. Next day, collections were made in subplot 2. This procedure was followed on successive days in subplots 3, 4, and 5. The procedure was repeated throughout the summer to prevent the daily disturbance of the population in any one subplot. Collections in region D, the open pond, were made each day with three sweeps about three yards long through the water with a dip-net having a mouth 10 inches in diameter.

Spiders and harvestmen were collected by examining bushes and the bark of trees and by scanning the ground, by looking under stones, boards, and debris on the ground, and by sweeping herbage, bushes, and the lower

branches of trees with an insect net with a mouth 10 inches in diameter. The specimens were identified by Dr. C.D. Dondale, Entomology Research Institute, Department of Agriculture, Belleville, Ontario. The names of families used in the following account are those used by Kaston (1948). All specimens are preserved in alcohol and distributed among the collections of the National Museum of Canada, the Entomology Research Institute, Belleville, and the Department of Zoology, University of Western Ontario. During the summer of 1961 Mr. M.S. Beverley aided in collecting and sorting specimens and in recording data.

## ACCOUNT OF TOTAL CATCH

A résumé of the collection of harvestmen and spiders is presented in Table 1. Altogether 85 harvestmen and 1,127 spiders were collected. More than half the harvestmen were from the drier, wooded slopes (c), most of the remainder from the damp, wooded region (b), and a few from the open, floating bog (a). None were found on the open pond (D). About three-quarters of the spiders were from the open bog and the lower damp woods, the majority of these from the open bog. Most of the remainder were from the dry wooded slopes, and only a few were from the open pond.

TABLE 1

Distribution of numbers of harvestmen and spiders among collecting sites in the Bog

| Order | Family | Collecting Sites | | | | Total |
|---|---|---|---|---|---|---|
| | | A | B | C | D | |
| Phalangida | Phalangiidae | 6 | 29 | 50 | 0 | 85 |
| Araneida | Theridiidae | 103 | 61 | 42 | 0 | 206 |
| | Linyphiidae | 44 | 25 | 1 | 0 | 70 |
| | Micryphantidae | 9 | 125 | 30 | 3 | 167 |
| | Epeiridae | 83 | 43 | 19 | 0 | 145 |
| | Theridiosomatidae | 0 | 1 | 0 | 0 | 1 |
| | Tetragnathidae | 11 | 49 | 11 | 1 | 72 |
| | Mimetidae | 5 | 0 | 0 | 0 | 5 |
| | Agelenidae | 1 | 0 | 0 | 0 | 1 |
| | Pisauridae | 5 | 5 | 2 | 14 | 26 |
| | Lycosidae | 1 | 28 | 48 | 4 | 81 |
| | Gnaphosidae | 0 | 1 | 0 | 1 | 2 |
| | Clubionidae | 5 | 5 | 5 | 0 | 15 |
| | Thomisidae | 32 | 27 | 33 | 0 | 92 |
| | Salticidae | 113 | 6 | 4 | 0 | 123 |
| | Dictynidae | 97 | 7 | 10 | 0 | 114 |
| | Uloboridae | 3 | 4 | 0 | 0 | 7 |
| | Total | 512 | 387 | 205 | 23 | 1,127 |
| Total | | 518 | 416 | 255 | 23 | 1,212 |

The predominance of spiders on the open bog was likely due to the abundant growth of bushes of leather-leaf, *Chamaedaphne calyculata*, thus providing sites for web-spinning, and to the abundant and varied population of insects associated with the leather-leaf (Judd, 1960) and thus available as prey. Of the sixteen families of spiders represented, eight were present in greatest numbers on the open bog (Table 1). Four families were present in their greatest numbers in the lower damp woods, i.e. Micryphantidae, Theridiosomatidae, Tetragnathidae, and Uloboridae. Two families, Lycosidae and Thomisidae, were present in their greatest numbers on the dry wooded slopes. This distribution is in accord with the report of Comstock (1948) that spiders in the Lycosidae are found in grass and under stones and those in the Thomisidae live on fences and under stones and bark. Such locations were most prevalent on the wooded slopes. One family, Pisauridae, was present in its greatest numbers on the pond, owing to the presence of *Dolomedes sexpunctatus* which lives on plants over water (Comstock, 1948). Comments on the seasonal and territorial distribution of each species are included under the 'Account of species collected'.

For some species which were collected in considerable numbers it was possible to plot the seasonal distribution of immature spiders and adults (Fig. 1). Four patterns of distribution were evident:

1. Adults occurring in spring and summer and immatures in fall. These included *Leiobunum formosum, Hyselistes florens* (Fig. 1), and *Dolomedes sexpunctatus*.

2. Adults occurring in spring and fall and immatures mainly during summer. This included *Pellenes hoyi* (Fig. 1).

3. Immatures occurring in spring and summer and adults in late summer and fall. These included *Leiobunum politum, Enoplognatha ovata, Theridula opulenta, Neoscona arabesca* (Fig. 1), *Philodromus placidus, Phidippus clarus, and Dictyna coloradensis*.

4. Immatures occurring in spring and fall and adults mainly in summer. These included *Theridion differens, T. frondeum, Frontinella communis* (Fig. 1), *Philodromus imbecillus, P. rufus, P. cespiticollis*, and *Icius similis*.

In group 1 are species in which the spiders evidently overwinter as immatures, becoming adult in spring and summer and producing a new generation in late summer. In group 2 are those which would overwinter as adults and produce young which would mature during the summer in time to produce a new generation of adults in the fall. In group 3 are those which would overwinter as adults and produce young which would mature during spring and summer. In group 4 are those which would overwinter as immatures and persist well into the next year and produce adults in summer. In all the species studied by Dondale (1961), including *Philodromus rufus* and *P. cespiticollis*, a single generation is added to the population annually. How-

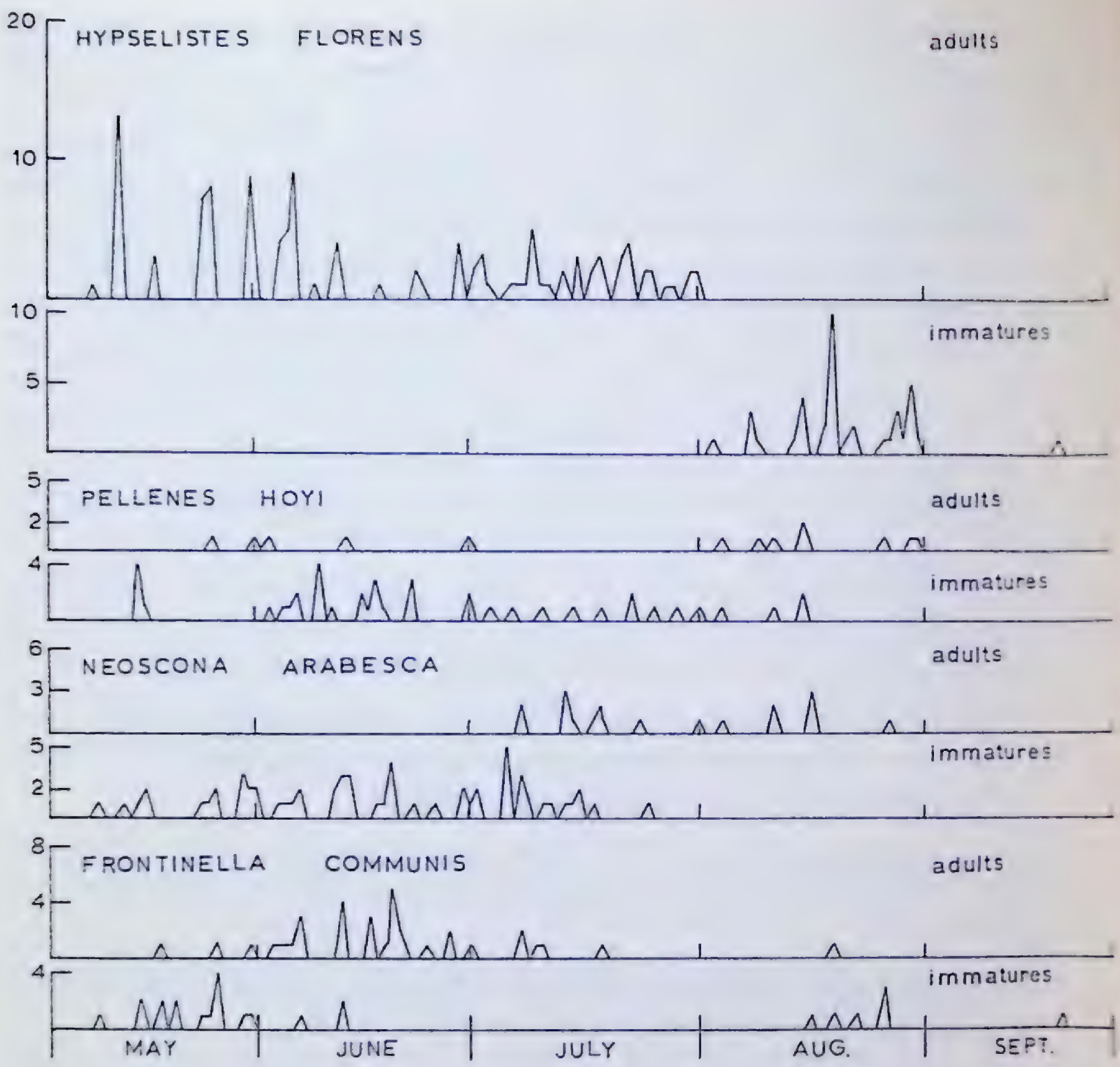


Figure 1 — Seasonal distribution of immatures and adults of four species of spiders

ever, Dondale points out that some of these are 'biennial' with two generations of immature spiders present during any year. Thus, among the spiders collected in the Byron Bog there may have been some in which immatures of two generations were present concurrently.

## ACCOUNT OF SPECIES COLLECTED

In the following account the numbers of males, females, and immatures, and the times of their collection are noted after the name of each species. Also included (in brackets) for each species are the numbers collected from the four collection areas a, b, c, and D respectively, followed by the total number collected.

### PHALANGIDA

#### Phalangiidae

*Leiobunum formosum* (Wood)–1 ♂ (May 29), 5 ♀♀ (May 17–31), 5 imm. (June 24 – July 8) ; (1, 0, 10, 0 : 11). This species was found mainly on the wooded slopes, with adults occurring in spring and immatures in early summer.

*Leiobunum politum* Weed–6 ♂♂ (July 23–August 28), 4 ♀♀ (July 23–August 20), 15 imm. (July 3–21) ; (0, 22, 3, 0 : 25). This species occurred mainly in the damp woods.

*Leiobunum ventricosum* (Wood)–2 ♀♀ (June 6, 8) ; (0, 2, 0, 0 : 2).

*Leiobunum verrucosum* (Wood)–20 ♂♂ (June 3 – July 20), 9 ♀♀ (June 3–23), 3 imm. (June 4, July 13, 24) ; (0, 0, 32, 0 : 32). All specimens were from the dry wooded slopes.

*Leiobunum vittatum* (Say)–1 ♂ (August 8), 5 ♀♀ (July 24 – August 29), 3 imm. (July 30, August 10) ; (5, 0, 4, 0 : 9).

*Leiobunum* sp.–5 imm. (June 15 – July 26) ; (0, 5, 0, 0 : 5).

*Phalangium opilio* L.–1 ♀ (July 10) ; (0, 0, 1, 0 : 1).

### ARANEIDA

#### Theridiidae

*Enoplognatha ovata* (Clerck)–12 ♂♂ (July 6–18), 19 ♀♀ (June 23 – August 8), 21 imm. (May 25 – July 17) ; (2, 11, 39, 0 : 52). This species occurred mainly on the wooded slopes and in lesser numbers in the lower damp woods.

*Robertus longipalpus* (Kaston)–1 ♂ (May 20) ; (0, 1, 0, 0 : 1).

*Robertus banksi* (Kaston)–1 ♂ (July 4), 1 ♀ (June 4) ; (0, 2, 0, 0 : 2).

*Robertus* sp.–1 imm. (July 9) ; (0, 1, 0, 0 : 1).

*Argyrodes trigonum* Hentz–2 ♂♂ (June 18, July 22) ; (1, 1, 0, 0 : 2). The occurrence of adults in June and July is in accord with the report of Kaston (1948) that this species matures in late May.

*Dipoena nigra* (Emerton)–1 ♂ (July 9); (1, 0, 0, 0 : 1). The occurrence of an adult in July is in accord with the report of Kaston (1948) that this species matures in late May.

*Paidisca unimaculata* (Emerton)–2 ♂♂ (June 11, 30), 1 ♀ (June 11) ; (3, 0, 0, 0 : 3).

*Theridula opulenta* (Walck.)–4 ♂♂ (June 18, 30), 4 ♀♀ (June 18–30), 13 imm. (May 17 – June 1, Aug. 18) ; (15, 6, 0, 0 : 21). This species was present mainly on the open bog but also in the adjacent lower woods. The occurrence of adults in June is in accord with the report of Kaston (1948) that this species matures in late May and early June.

*Theridion differens* Emerton–18 ♂♂ (May 19 – July 8), 26 ♀♀ (May 25 – August 17), 41 imm. (May 12 – June 9, July 16 – September 8) ; (78, 7, 0, 0 : 85). The predominance of this species in the open bog is in accord with the report of Kaston (1948) that it occurs in low bushes, and the presence of adults in May is in accord with his report that maturity occurs in that month.

*Theridion murarium* Emerton–1 ♂ (July 16), 3 imm. (May 13, 24, August 22) ; (2, 2, 0, 0 : 4). The presence of this species in the open bog and the damp woods is in accord with the report of Kaston (1948) that it is found in spruce trees. Black spruce is present in both these regions of the bog (Judd, 1957).

*Theridion frondeum* Hentz–3 ♂♂ (July 12–18), 11 ♀♀ (July 2 – August 8), 1 imm. (May 24) ; (0, 12, 3, 0 : 15). The presence of adults in July is in accord with the report of Kaston (1948) that this species matures in late June.

*Theridion albidum* Banks–1 ♀ (July 13), 12 imm. (May 17 – June 12) ; (1, 12, 0, 0 : 13).

*Theridion* sp.–6 imm. (June 11–24) ; (0, 6, 0, 0 : 6).

## Linyphiidae

*Pityohyphantes costatus* (Hentz)–1 imm. (August 20) ; (0, 1, 0, 0 : 1). The presence of this species in the damp woods is in accord with the report of Levi and Field (1954) that it usually occurs in woods.

*Frontinella communis* (Hentz)–8 ♂♂ (May 17 – June 24), 28 ♀♀ (June 2 – August 18), 25 imm. (May 8 – June 12, August 15 – September 22) ; (44, 17, 0, 0 : 61). The predominance of this species in the open bog and the damp woods is in accord with the report of Kaston (1948) that it is found in pine woods and low branches. White pine is present in the bog (Judd, 1957).

*Bathyphantes pallida* (Banks)–1 ♂ (July 2), 6 ♀♀ (May 23 – August 13) ; (0, 7, 0, 0 : 7).

*Bathyphantoides brevis* (Emerton)–1 ♀ (August 30) ; (0, 0, 1, 0 : 1).

## Micryphantidae

*Hypselistes florens* (O.P.–Cambridge)–12 ♂♂ (May 8 – June 6), 107 ♀♀ (May 12 – August 21), 38 imm. (August 2 – September 23) ; (3, 124, 30, 0 : 157). This species predominated in the low, damp woods. The presence of immatures in the fall is in accord with the report of Kaston (1948) that this species hibernates in the immature state.

*Erigone autumnalis* Emerton–1 ♀ (June 16) ; (0, 0, 0, 1 : 1).

*Grammonota gigas* (Banks)–2 ♂♂ (June 24, July 16) ; (0, 0, 0, 2 : 2) . The presence of this species on the pond is in accord with the report of Kaston (1948) that it is found in swamps and salt marshes.

*Grammonota angusta* Dondale–1 ♂ (June 22), 2 ♀♀ (June 16, July 18), 3 imm. (May 12, 17, June 22) ; (5, 1, 0, 0 : 6).

*Ceratinopsis nigriceps* Emerton–1 ♂ (June 9) ; (1, 0, 0, 0 : 1).

## Epeiridae

*Argiope trifasciata* (Forskal) –1 imm. (August 10) ; (1, 0, 0, 0 : 1).

*Mangora placida* (Hentz)–6 ♀♀ (June 2 – July 6), 5 imm. (May 12, 13, June 18) ; (2, 7, 2, 0 : 11). The occurrence of immatures in May is in accord with the report of Kaston (1948) that this species overwinters in the immature state.

*Mangora gibberosa* Hentz–7 ♀♀ (July 13, August 5, 18), 6 imm. (July 7–23) ; (3, 8, 2, 0 : 13). The occurrence of immatures in July and of adults in July and August is in accord with the report of Kaston (1948) that this species matures at the end of July.

*Mangora maculata* (Keyserling)–1 ♀ (August 10) ; (0, 1, 0, 0 : 1). The presence of this species in the low, damp woods is in accord with the report of Kaston (1948) that this species produces its snares in low vegetation in forests.

*Singa truncata* Banks–1 ♂ (June 23) ; (1, 0, 0, 0 : 1).

*Neoscona arabesca* (Walckenaer)–7 ♂♂ (July 13 – August 15), 11 ♀♀ (July 7 – August 26), 59 imm. (May 8 – July 24) ; (64, 9, 4, 0 : 77). The predominance of this species in the open bog is in accord with the report of Kaston (1948 ) that it occurs in bushes.

*Neoscona* sp.–5 imm. (June 5–29) ; (0, 5, 0, 0 : 5).

*Araneus diadematus* Clerck–1 ♀ (August 29) ; (0, 0, 1, 0 : 1).

*Araneus* sp.–1 ♂ (August 30), 32 imm. (June 5 – August 29) ; (11, 13, 9, 0 : 33).

*Araniella displicata* (Hentz)–1 ♀ (June 16), 1 imm. (May 29) ; (1, 0, 1, 0 : 2). The presence of an immature in May and of an adult in June is in accord with the report of Kaston (1948) that this species overwinters in the young stages.

Theridiosomatidae

*Theridiosoma gemmosa* (L. Koch)–1 ♂ (June 15) ; (0, 1, 0, 0 : 1).

Tetragnathidae

*Pachygnatha brevis* Keyserling–1 ♂ (August 13), 1 imm. (July 17) ; (0, 2, 0, 0 : 2).

*Pachygnatha* sp.–2 imm. (July 16, August 7) ; (0, 1, 0, 1 : 2).

*Tetragnatha laboriosa* Hentz–4 ♀♀ (May 14 – July 10) ; 8 imm. (June 4 – August 29) ; (1, 7, 4, 0 : 12).

*Tetragnatha versicolor* Walck.–8 ♂♂ (May 17 – July 24), 5 ♀♀ (June 4 – July 11), 18 imm. (May 17 – June 16, August 3–29) ; (0, 26, 5, 0 : 31).

*Tetragnatha straminea* Emerton–4 ♀♀ (June 18, July 25), 5 imm. (July 23 – August 7) ; (0, 8, 1, 0 : 9).

*Tetragnatha vermiformis* Emerton–1 ♀ (July 18) ; (0, 0, 1, 0 : 1).

*Tetragnatha* sp.–15 imm. (May 12 – June 9, August 18 – Sept. 29) ; (10, 5, 0, 0 : 15).

Mimetidae

*Mimetus puritanus* Chamberlin–2 ♂♂ (July 7, 11) ; (2, 0, 0, 0 : 2). The presence of this species in the open bog is in accord with the report of Kaston (1948) that it occurs in low bushes.

*Mimetus* sp.–3 imm. (May 24 – June 1) ; (3, 0, 0, 0 : 3).

Agelenidae

*Agelenopsis potteri* (Blackwall)–1 ♀ (September 8) ; (1, 0, 0, 0 : 1).

Pisauridae

*Dapanus* sp.–1 ♀ (August 30), 10 imm. (May 17 – August 25) ; (5, 5, 1, 0 : 11).

*Dolomedes sexpunctatus* Hentz–1 ♂ (May 23), 14 imm. (May 24 – June 8, July 23 – August 28) ; (0, 0, 1, 14 : 15). The predominance of this species on the pond is in accord with the report of Kaston (1948) that it is

found in swamps and marshes, and on ponds ; and the presence of immatures in spring and late summer accords with his report that the immatures hibernate.

Lycosidae

*Pirata minutus* Emerton–12 ♀♀ (June 22 – August 24) ; (0, 0, 10, 2 : 12). The occurrence of adults from June to August is in accord with the report of Kaston (1948) that this species matures in May and June.

*Pirata piratica* (Clerck)–3 ♀♀ (June 5–23), 1 imm. (June 26); (0, 3, 1, 0 : 4).

*Pirata insularis* Emerton–2 ♂♂ (June 19, July 7), 24 ♀♀ (June 19 – September 15), 2 imm. (June 27, July 10) ; (0, 19, 8, 1 : 28).

*Pirata arenicola* Emerton–4 ♀♀ (July 10 – August 28) ; (0, 0, 4, 0 : 4).

*Pirata* sp.–9 imm. (May 8 – June 29) ; (0, 4, 4, 1 : 9).

*Schizocosa avida* (Walck.)–1 ♀ (June 16) ; (0, 0, 1, 0 : 1).

*Trochosa pratensis* (Emerton)–1 ♀ (July 10), 3 imm. (July 16, August 27, 28) ; (0, 1, 3, 0 : 4). The occurrence of this species in the low, damp woods and on the wooded slopes is in accord with the report of Kaston (1948) that it is found among dead leaves on the forest floor.

*Pardosa moesta* Banks–11 ♀♀ (June 17 – August 21) ; (1, 0, 10, 0 : 11). The presence of this species on the wooded slopes is in accord with the report of Kaston (1948) that it occurs at the edge of woods; and its seasonal distribution accords with his report that adults appear from June to August.

*Pardosa milvina* (Hentz)–1 ♂ (August 8) 2 ♀♀ (June 16, August 13) ; (0, 0, 3, 0 : 3).

*Pardosa saxatilis* Hentz–1 ♀ (July 8) ; (0, 0, 1, 0 : 1).

*Pardosa* sp.–4 imm. (May 10 – June 5, August 11) ; (0, 1, 3, 0 : 4).

Gnaphosidae

*Drasyllus fallens* Chamberlin–1 ♀ (June 11) ; (0, 1, 0, 0 : 1).

*Drasyllus* sp.–1 imm. (August 19) ; (0, 0, 0, 1 : 1).

Clubionidae

*Clubiona abboti* L. Koch–4 ♂♂ (July 15, August 5, 30), 2 ♀♀ (July 15, 28) ; (0, 3, 3, 0 : 6).

*Clubiona* sp.–8 imm. (June 15 – August 30) ; (5, 1, 2, 0 : 8).

*Agroeca* sp.–1 imm. (May 16) ; (0, 1, 0, 0 : 1).

Thomisidae

*Misumena vatia* (Clerck)–1 ♀ (July 30), 4 imm. (June 29 – July 14); (0, 4, 1, 0 : 5).

*Misumenoides aleatorius* (Hentz)–1 ♂ (August 18) ; (1, 0, 0, 0 : 1).

*Misumenops oblongus* (Keyserling)–1 ♂ (July 1) ; (0, 0, 1, 0 : 1).

*Misumenops asperatus* (Hentz)–1 ♂ (June 3) ; (1, 0, 0, 0 : 1).

*Misumenops* sp.–1 imm. (June 6) ; (0, 1, 0, 0 : 1).

*Tmarus* sp.–1 imm. (August 18) ; (0, 0, 1, 0 : 1).

*Oxyptila* sp.–1 imm. (July 27) ; (1, 0, 0, 0 : 1).

*Xysticus* sp.–2 imm. (July 17, August 30) ; (1, 0, 1, 0 : 2).

*Philodromus placidus* Banks–1 ♂ (July 18), 3 ♀♀ (July 11, 24, August 18), 10 imm. (May 15 – August 18) ; (0, 14, 0, 0 : 14). The predominance of this species in the damp woods is in accord with the report of Kaston (1948) that it occurs in trees.

*Philodromus imbecillus* Keyserling–4 ♂♂ (June 6 – July 17), 14 imm. (May 17 – June 12, August 10–19) ; (17, 0, 1, 0 : 18).

*Philodromus rufus* Walckenaer–2 ♀♀ (July 18, 25) 4 imm. (May 8, June 19, 30, August 28) ; (2, 2, 2, 0 : 6).

*Philodromus cespiticollis* Walckenaer–2 ♂♂ (June 26, July 18), 1 ♀ (July 1), 20 imm. (May 25 – July 12, August 18) ; (0, 0, 23, 0 : 23). This species predominated on the dry wooded slopes.

*Tibellus oblongus* Walckenaer–2 ♀♀ (June 25, July 14), 1 imm. (August 5) ; (0, 1, 2, 0 : 3).

*Tibellus* sp.–15 imm. (May 25 – August 25) ; (9, 5, 1, 0 : 15).

Salticidae

*Pellenes hoyi* (Peckham)–12 ♂♂ (May 31 – June 30, August 3–30), 6 ♀♀ (May 25 – July 27), 41 imm. (May 14 – August 14) ; (56, 3, 0, 0 : 59). The predominance of this species on the open bog is in accord with the report of Kaston (1948) that it is found in bushes.

*Metaphidippus galathea* (Walckenaer)–3 ♂♂ (June 3–25), 4 ♀♀ (June 18 – August 5) ; (6, 1, 0, 0 : 7).

*Metaphidippus flavipedes* (Peckham)–3 ♂♂ (June 6–25), 1 ♀ (May 31) ; (3, 1, 0, 0 : 4).

*Metaphidippus* sp.–7 imm. (May 14 – July 3, September 29) ; (7, 0, 0, 0 : 7).

*Paraphidippus marginatus* (Walck.)–1 ♂ (June 4), 1 imm. (May 29) ; (2, 0, 0, 0 : 2).

*Phidippus clarus* Keyserling–1 ♂ (July 15), 19 imm. (May 24 – July 13) ; (20, 0, 0, 0 : 20). The predominance of this species on the open bog is in accord with the report of Kaston (1948) that it occurs on bushes.

*Icius similis* Banks–2 ♂♂ (July 1, 13), 1 ♀ (June 29), 5 imm. (May 31 – June 15, September 22) ; (7, 0, 1, 0 : 8).

*Hentzia palmarum* (Hentz)–5 ♂♂ (June 3–25, August 26), 6 ♀♀ (May 31 – July 23), 5 imm. (May 24 – August 29) ; (12, 1, 3, 0 : 16). The predominance of this species on the open bog is in accord with the report of Kaston (1948) that it occurs on bushes.

## Dictynidae

*Dictyna sublata* (Hentz)–1 ♂ (May 31), 7 ♀♀ (May 25 – July 9, August 18) ; (0, 0, 8, 0 : 8).

*Dictyna hentzi* Kaston–2 ♂♂ (June 18), 5 ♀♀ (June 1 – July 21), 1 imm. (June 25) ; (7, 0, 1, 0 : 8).

*Dictyna cruciata* Emerton–5 ♀♀ (June 23 – July 10) ; (0, 4, 1, 0 : 5). The presence of adults in June and July is in accord with the report of Kaston (1948) that it matures in June.

*Dictyna minuta* Emerton–2 ♀♀ (June 26, August 15) ; (0, 2, 0, 0 : 2).

*Dictyna coloradensis* Chamberlin–20 ♂♂ (May 17 – June 16), 20 ♀♀ (May 25 – July 9), 17 imm. (May 13–23) ; (56, 1, 0, 0 : 57). This species predominated in the open bog.

*Dictyna* sp.–34 imm. (July 22 – September 29) ; (34, 0, 0, 0 : 34).

## Uloboridae

*Hyptiotes cavatus* (Hentz)–2 ♂♂ (August 28, 30), 2 ♀♀ (August 21, 28), 1 imm. (August 25) ; (2, 3, 0, 0 : 5). The seasonal distribution of this species is in accord with the report of Kaston (1948) that it matures by August.

*Uloborus glomosus* Walck.–1 ♀ (June 12), 1 imm. (May 31) ; (1, 1, 0, 0 : 2).

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Number 29 January 8, 1965

NATIONAL MUSEUM OF CANADA **NATURAL HISTORY PAPERS**

# Fish Remains from a 2,500-year-old Lake Superior Archaeological Site, with Notes on Previous Sites

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Department of the Secretary of State

ROGER DUHAMEL, F.R.S.C.
QUEEN'S PRINTER AND CONTROLLER OF STATIONERY
OTTAWA, 1964
Cat. No. NM95-5/29

NATIONAL MUSEUM OF CANADA NATURAL HISTORY PAPERS

# Fish Remains from a 2,500-Year-Old Lake Superior Archaeological Site, with Notes on Previous Sites

D.E. McAllister and S.U. Qadri*

Fish remains, bones and scales, were discovered during the 1960, 1961, and 1963 investigations of a Laurel Tradition, Middle Woodland site by Dr. J.V. Wright. The site is located at Heron Bay near the bank of the Pic River up from its mouth on northern Lake Superior, near the town of Marathon, Ontario. A seriational estimate of the date of the site places it at about 500 B.C., i.e., about 2,500 years old.

The fish specimens were obtained from a depth of about 9 inches. The bones are tinged brown; a few are burnt. An indication of how the fish were caught is given by the presence of gill net sinkers and copper gorges. An archaeological description of the site will be presented in a forthcoming bulletin of the National Museum of Canada. The fish specimens are catalogued under NMC 64–39 of the fish collection of the National Museum of Canada.

## SPECIES REPRESENTED

### Acipenseridae

*Acipenser fulvescens* Mitchill – lake sturgeon

The lake sturgeon was represented by plates of the skull, by scutes and by fulcra (see fig. 1). Sturgeon bones were the most common in the deposit. External skeletal elements were readily recognizable because of their dimpled surface.

*St. Patricks College and Department of Biology, University of Ottawa. MS. completed June 2, 1964.

## Salmonidae

*Salvelinus namaycush*[1] (Walbaum) – lake charr

The lake charr was represented by a small anterior portion of the dentary. The size and shape of the dentary alveoles in the lake charr are different from those of the brook charr, with which it might be confused.

A small and broken piece of the frontal bone may be attributed to the subgenus *Cristivomer*, or to *Salvelinus*. However, the massiveness of the bone points to the fact that it probably belongs to *Cristivomer*.

*Coregonus* – whitefish or cisco

The subgenus *Leucicthys* (fig. 5) is represented by three maxillae.

A preoperculum, by its shape and by the structure of the preopercular sensory canal, is suggestive of the genus *Coregonus*.

*Prosopium cylindraceum* (Pallas) – round whitefish

The round whitefish was represented by three scales. These were identified using the key and figures in Lagler (1947). The salient scale characteristics were: cycloid, primary radii absent, focus well defined, two anterior angles joined by bow-shaped curve, narrowly spaced circuli of ovoid form (the long axis being antero-posterior).

The genus *Prosopium* is also represented by a single opercle (fig. 6). Identification to species is impractical. However, its width, 17 mm, would eliminate the only other species, *P. coulteri*, presently known in the area.

## Esocidae

*Esox lucius* Linnaeus – northern pike

The northern pike was represented by three dentaries, five canine teeth, a quadrate, and an operculum. Dr. E.J. Crossman kindly identified the material to species (see fig. 2).

## Catostomidae

*Catostomus catostomus* (Forster) – longnose sucker

Three opercular may be attributed to this species (see fig. 3). Other material, preoperculars, a mandible, and a cleithrum, may at the moment be identified only to the family, but might belong to this species.

## Percidae

*Stizostedion vitreum* (?) (Mitchill) – walleye

To the genus *Stizostedion* may be referred three mandibula, three premaxilla, two maxilla, three cleithra, one palatine, one vomer, one angular, and three quadrates (not all bones complete) (see fig. 4).

[1] The junior author is completing a study to bring forth evidence for generic recognition of *Cristivomer*.

Dr. Bruce Collette has kindly examined this material. On the basis of quadrate and dentary measurements compared with those from specimens of known size, the specimens from the archaeological site are indicated to be about 42, 48, and 53 cm long. He suggests it is quite probable that at least the larger, and perhaps all, specimens were *S. vitreum* (rather than the other small species, *S. canadense*).

## ADDITIONS TO SITES PREVIOUSLY REPORTED

McAllister (1962) reported remains of *Stizostedion* sp. from the Goessens site near Lake Erie (A.D. 1200; NMC62–113–S) and the Donaldson site, near Lake Huron (2480 ± 60 years BP; NMC62–114–S). Dr. Bruce Collette also examined this material. On the same basis the NMC62–113–S specimens were about 35 cm, the NMC62–114–S specimens about 43 cm and 45 cm long. On the basis of size it is therefore quite probable that at least the larger and perhaps all the specimens were *S. vitreum*.

Wintemberg (1936) reported buffalo fish, possibly *Ictiobus bubalis* from the 400-year-old Roebuck (revised date estimate, previously considered 600) site in the vicinity of Prescott, Ontario. McAllister (1961) repeated Wintemberg's record, although he questioned it. The original material has now been located, and Dr. R.R. Miller kindly checked its identification. He states: "In conclusion, I see no confident basis for reference of the remains to *Ictiobus* (certainly not to *I. bubalis*), whereas in all likelihood two or three species of *Moxostoma* are involved." The species possibly represented are *anisurum, erythrurum, valenciennesi,* and *macrolepidotum*. But the material lacks critical characters, and it has not been possible to compare the material with skeletons of *M. hubbsi*. It would therefore seem best to consider the material identified only to genus. Miller's re-identification to *Moxostoma* solves the dilemma of finding recent *Ictiobus* remains outside its present range.

## ZOOGEOGRAPHIC IMPLICATIONS

The ichthyofauna represented by remains may best be described as cool boreal. All the species recovered from the site are found in the same general area at the present time. But these are not a random sample of species present today (but which could be found in an archaeological site). None of the species present have the midpoint of their present range to the south of the site. One form, the lake sturgeon, has the midpoint of its range at about the latitude of the site. The other six forms have the midpoint of their present range north of the site. None of the warmwater species found at other Ontario archaeological sites were found at the Pic site. These warmwater species include the longnose gar, the freshwater drum, the yellow perch, the catfishes, and black basses (McAllister, 1961, 1962). So the climate was no warmer than now.

It is a little surprising that warmwater relicts of the postglacial hypsithermal period were not found. The hypsithermal period lasted from about 7,000 to nearly 3,000 years ago; the peak, 6,000 to 4,000 years ago (Terasmae, 1961). In this regard it may be noted that Hubbs and Lagler (1949, p. 86) suggested that some of the fishes of Isle Royale, Lake Superior, were warmwater relicts from the hypsithermal. However, it is possible that few if any warmwater species penetrated as far north as the Pic River. Further, antilatitudinal thermal transport by the Pic, the movement of cool water south from cooler latitudes, might render the Pic site cool. Alternately the warmwater species may already have retreated southwards by 2,500 years ago.

The fish remains not only assist in assessing the climate at the time but also provide evidence as to which glacial refugia the fish survived in.

That these seven forms were present there as long ago as 2,500 years B.P. makes it more likely that they dispersed from a nearby southern refugium following the Wisconsin glaciation, than that they dispersed from the distant Bering or Pacific refugia. McPhail (1963) agrees in suggesting that *Prosopium cylindraceum, Cristivomer namaycush, Catostomus catostomus, Esox lucius,* and *Stizostedion vitreum* were in the Mississippian refugium during the Wisconsin. The present distributions of *Acipenser fulvescens* and *Coregonus* (subgenus *Leucichthys:* southern species) sp. suggest also that they survived in the Mississippi refugium (Some of these species survived in other refugia as well).

## SUMMARY

Remains of the following forms were found in a 2,500-year-old Laurel Tradition, Middle Woodland archaeological site on the Pic River near Marathon, Ontario: *Acipenser fulvescens, Cristivomer namaycush, Coregonus* (subgenus *Leucichthys)* sp., *Prosopium cylindraceum, Esox lucius, Catostomus catostomus,* and *Stizostedion vitreum.* The ichthyofauna may be described as cool boreal. Because of the age of the site, probability is added to the suggestion that these forms survived in a nearby southern refugium during the Wisconsin glaciation. More definitive identifications of material from previously reported Ontario archaeological sites are presented.

## Acknowledgments

The author is very grateful to Dr. E.J. Crossman of the Royal Ontario Museum for identification of the *Esox* remains, to Dr. Bruce B. Collette of the Ichthyological Laboratory, United States National Museum, for identification of *Stizostedion* remains, and to Dr. R.R. Miller of the University of Michigan Museum of Zoology, who generously re-identified the *Moxostoma*

material. To Dr. J.V. Wright, the author is indebted for permission to study the material and for information on the site. Mr. F.R. Cook kindly criticized the manuscript. Mr. John Crosby photographed the bones in the last two figures.

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Fig. 1. Scutes, bones and fulcra of the lake sturgeon, *Acipenser fulvescens*.

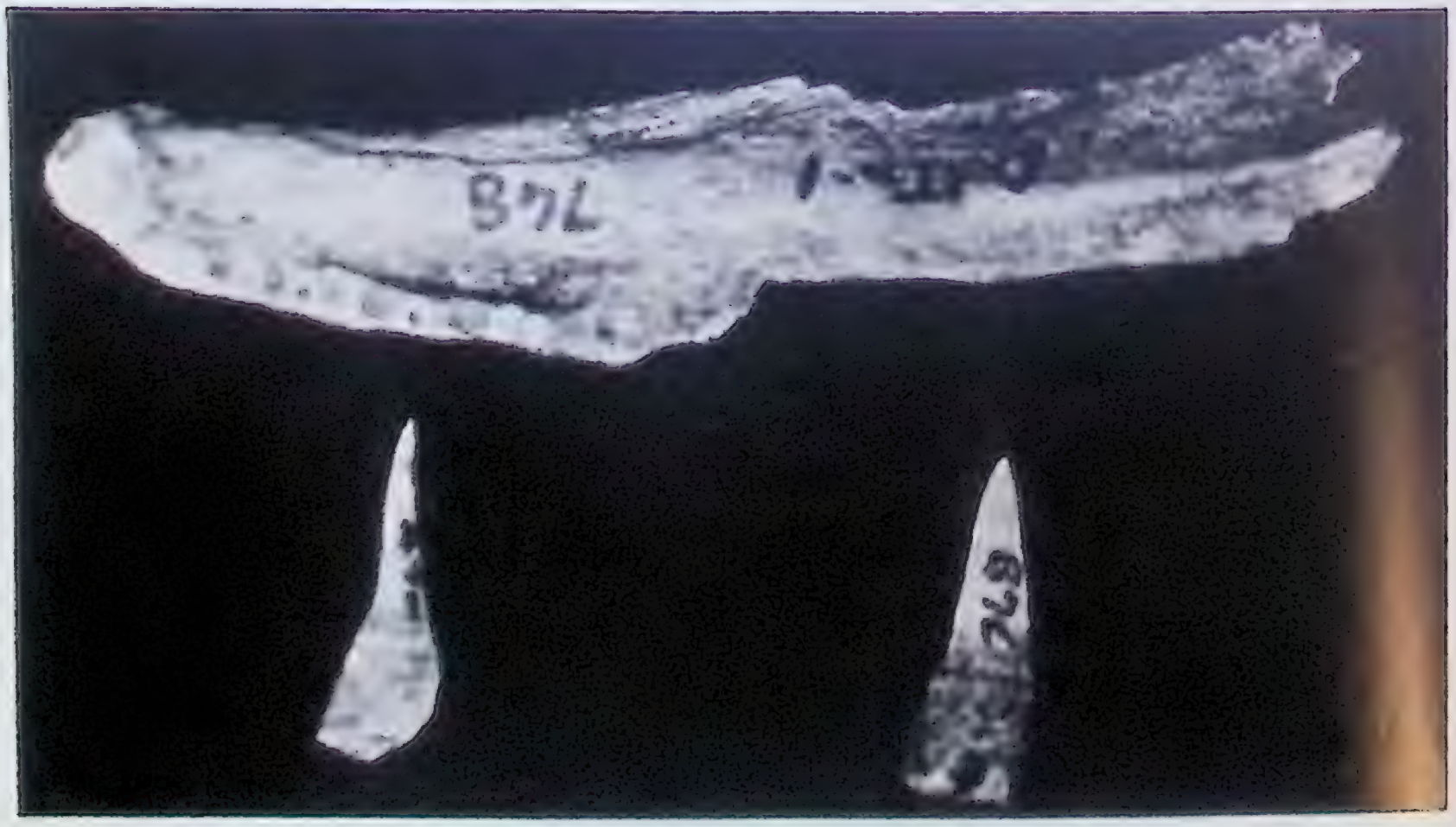

Fig. 2. Dentary and teeth of the northern pike, *Esox lucius*.

Fig. 3. Opercular bones of the longnose sucker, *Catostomus catostomus*.

Fig. 4. Palatine (above) and dentary referred to the walleye, *Stizostedion vitreum*.

Fig. 5. Maxillaries of a cisco, *Coregonus (Leucichthys)*.

Fig. 6. Operculum probably referable to the round whitefish, *Prosopium cylindraceum*.

Can. Nat. Mus.
Nat. Hist. Papers
Nos. 1-29, 1958-65
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